Official Proceedings

Western Railway Club

Official Proceedings

OF THE

Western Railway Club

FOR THE

Club Year 1906-1907

The Club meets the third Tuesday of each month, except June, July and August.
The Club Year ends with the meeting in May.

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WESTERN RAILWAY CLUB

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1907

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, September 18th, President H. T. Bentley in the chair. The meeting was called to order at 8 o'clock.

Among those present the following registered:

Arbuthnot, J. B.
Ball, A. L.
Barton, T. F.
Bentley, H. T.
Bird, Geo.
Bott, A. G.
Broman, J. G.
Bryant, G. H.
Buell, D. C.
Carlton, L. M.
Clark, H. H.
Conger, C. B.
Cooke, W. J.
Cunningham, A. J.
DeGroot, E. H. Jr.
Dewey, L. R.
Dolly, J. M.
Doud, Willard
Edwards, F. W.
Endsley, L. E.
Fantom, W. F.
Fogg, J. W.
Fry, C. H.
Goss, W. F. M.
Haig, M. H.
Hammond, W. S. Jr.
Harahan, J. T. Jr.
Harrison, W. L.
Hibbard, M. W.
Higgins, C. C.
Hill, C. P.
Hincher, W. W.
Hubbell, I. C.
Hull, E. E.
Jenks, C. D.
Jett, E. E.
Kadish, R. B.
Kelly, J. W.
Kucher, T. N.
LaRue, H.
Leach, W. B.
Lewis, J. H.
Libekeman, W. A.
Linn, H. R.
McApine, A. R.
McLelland, H. B.
Mans, N. R.
Monroe, M. S.
Nistle, G. W.
Nuttall, W. H.
Ott, O. W.
Otto, O.
Park, H. S.
Peabody, J. A.
Peck, P. H.
Peterson, F. W.
Pratt, E. W.
Russell, M. F.
Schlacks, W. J.
Schreiner, Peter
Seley, C. A.
Stott, A. J.
Swan, C. A. Jr.
Taylor, J. W.
Thompson, E. B.
Vincent, M. M.
Vissering, Harry
Wallace, W. G.
Wickhorst, M. H.
Wright, Wm.
Younglove, J. C.

PRESIDENT BENTLEY: The first order of business of the evening is approval of the minutes of the last meeting. These have been printed and distributed, and if there are no corrections, they will stand as printed.

The next order of business is the report of the Secretary.

THE SECRETARY: Mr. President, I have the following membership list:

Name	Occupation and Address	Proposed by
Geo. A. Richardson,	C. M. & St. P. Ry., Chicago	J. W. Taylor
H. P. Latta,	S. M. P., Mobile, Jackson & Kansas City R. R., Mobile, Ala	J. W. Taylor
M. D. Stewart,	Fitz-Hugh Luther Co., Chicago	J. W. Taylor
F. H. Sweringen,	M. C. B. Streets Western Stable Car Line, Chicago	J. W. Taylor
Edw. F. O. Boyle,	International Correspondence Schools, Chicago	J. W. Taylor
Chas. L. Dinsmore,	Ry. Equipment & Pub. Co., Chicago	J. W. Taylor
C. E. Slayton,	M. M. Deepwater Ry., Page, W. Va	J. W. Taylor
John Kirkley,	Mech. & Elect. Engineer, Chesterfield, Eng.	J. W. Taylor
Jas. A. Lounsbury,	Greenlee Bros. & Co., Chicago	J. W. Taylor
P. M. Holdsworth,	Draftsman, Mo. Pac. Ry., St. Louis	R. L. McIntosh
J. J. Ellis,	S. M. P., C. S. & P. M. & O. Ry., Minneapolis, Minn.	G. H. Bryant
B. F. Sipp,	50 St. James Place, Chicago	M. K. Barnum
M. Marea,	R. F. E., T. St. L. & W. R. R., Frankfort, Ind.	P. Maher
R. J. McGrail,	C. C.—S. M. P. I. St. L. & W. R. R., Frankfort, Ind.	P. Maher
H. W. Johnson,	M. M. C. B. & Q. Ry., Brookfield, Mo.	A. N. Willsie
H. R. Llewellyn,	C. C.—M. M., C. B. & Q. Ry., Brookfield, Mo.	A. N. Willsie
S. C. Graham,	M. M., C. M. & St. P. Ry., Kaukauna, Wis.	H. T. Bentley
Walter Alexander,	A M. M., C. M. & St. P. Ry., W. Milwaukee, Wis.	G. N. Prentiss
Milton E. Shaver,	Draftsman Western Steel Car & Fdy. Co., Hedgwisch, Ind.	Wm. Wright
R. C. Taft,	Draftsman Western Steel Car & Fdy. Co., Chicago, Ill.	Wm. Wright
Thos. S. Waltemeyer,	Prist. & G. M., Rocky Mtn. Ry., Boulder, Colo.	M. T. Jones
Chas. H. Welch,	M. M., Midland Valley R. R., Excelsior, Ark.	J. W. Taylor
A. A. Kellogg,	Chief Draftsman, I. St. L. & W. R. R. Frankfort, Ind.	P. Maher
C. A. Ralston,	Hicks Loco. & Car Wks., Chicago, Ill.	J. W. Taylor
C. A. Swan, Jr.,	Hicks Loco. & Car Wks., Chicago, Ill.	J. W. Taylor
S. T. Park,	S. M. P., C. & E. I. R. R., Danville, Ill.	J. W. Taylor
W. O. Brewster,	Draftsman, C. B. & Q. Ry., Chicago, Ill.	O. W. Ott
C. I. Hutton,	Burma Rys. Co., Ltd., Insein, Burma, India	H. A. Craig

REINSTATED.

A. Z. Taylor, Car Foreman, C. M. & St. P. Ry., Tomahawk, Wis.

RESIGNED.

B. A. Worthington	T. H. Markle	M. T. Davis
T. Edwin Hall	E. J. Correll	E. A. Bern
G. A. McLean	C. C. Nuckols	Oscar Antz
T. H. Emmert	H. T. Shoad	John Medway
W. H. Collins	E. L. Essley	Geo. E. Ellis
Irving Wellman		

MAIL RETURNED—NO ADDRESS.

W. A. Rider Einer Palm

Membership, May, 1906		1,281
New Members approved by the Board of Directors	28	
Reinstated	1	29
		1,310
Resigned	16	
Mail returned	2	18
		1,292

THE SECRETARY: Mr. President, I also have the report of the Auditing Committee which was appointed at the May meeting.

Your auditing committee has examined the books of the Secretary and Treasurer and find same correct up to May 15, 1906.

9-15-'06 GUSTAVE THURNAUR.
W. E. SYMONS.

PRESIDENT BENTLEY: Gentlemen, on account of sickness at the last meeting, when the members did me the honor of making me president of this Club, I was unable to be present, and I wish to take this opportunity of thanking you for the honor that you have done me. I only hope that the growth of the Club will be as great in the next twelve months as it has been in the past year. Under the energetic management of my predecessor, the Club has grown by leaps and bounds and the enthusiasm that has been injected into the Club has been the source of great gratification to everybody concerned. I take this opportunity of thanking you for the very great honor you have conferred upon me and hope you will support me as nobly in the future as you have my predecessor in the past. (Applause).

Tonight we have with us Mr. J. F. Chriswell of the Hartford Steam Boiler Inspection and Insurance Company, and Mr. Foord of the same company.. Mr. Chriswell will give us a little talk on the subject of boiler explosions, which will be followed up by stereopticon views by Mr. Foord. After the gentlemen mentioned have given us their talks, Mr. Seley has something very important for the members to listen to. He has some suggestions from the Committee on Revision of Standard and Recommended Practice of the M. C. B. Association relating to the protection of trainmen. After the stereopticon views and the discussion that follows have taken place, I would ask that you retain your seats for a short time to allow Mr. Seley to bring this matter to your attention. Mr. Chriswell, gentlemen.

MR. J. F. CHRISWELL: Mr. President and Members of the Western Railway Club. It was with some feeling of reluctance that I accepted the invitation of your Secretary to talk to you tonight.

If I were an orator, I would say, address you,—but not having been born one, I hope you will accept a plain business talk.

I am supposed to be an insurance man, and I wondered what I should say that would be of interest to you gentlemen, for I am sure you are more interested in mechanics than you are in insurance. My line of work is secondary to the real thing,—or incidental, so to speak, for I am not supposed to know a boiler from a haystack, so that my talk will be in the way of some introductory remarks leading up to the main subject, the remarks of Mr. Foord. Mr. Foord and I are placed in the position of two boys who were about to go in swimming for the first time in the early spring, when the water was cold. Each fellow wanted the other to plunge in first. Mr. Foord being naturally timid, while I (according to him) being the best bluffer,—and you have to be that in the insurance business,—I have to wade in first. The only trouble with Foord is, that when the first chill wears off, he don't know when to wade out, so I want to prepare you in advance.

My position in our business is something like the Irishman who came to this country. You have probably all heard the story of how he came over here to take a job of carrying brick and mortar and he wrote back to his brother that he had a fine job; all he had to do was to carry up the brick and mortar to the top of the building and the other fellows had to do the work. I am supposed to go out and get the business, bring in the boilers to be inspected and insured and Foord does all the work. It is very easy.

It may be interesting to you gentlemen, perhaps to know something of the history connected with the origin of the steam boiler inspection and insurance.

In the year 1857 a number of young men in Hartford were drawn together by a similarity of tastes (just as you gentlemen are), and they organized the Polytechnic Club, with the view of investigating and discussing questions of science. A Prof. Tyndall, in one of his lectures before the club, touched on the subject of boiler explosions and their causes. This became the text of frequent talks on explosions, and the best method of preventing them. One of the members on returning from a European trip, brought with him the results of experiments that had been conducted in England. It also became known that the Manchester Steam Users' Association had already been organized with the object of preventing boiler explosions by periodical inspections. Under the system the steam user paid a certain sum annually for the examination, receiving a certificate of the safe condition of his boiler, or a report condemning it. But the certificate, like those now issued by the appointees of City or State in this country, involved no pecuniary obligation on the part of the Association and while it relieved the holder from the charge of carelessness in a measure, it entitled him to no indemnity in case of an explo-

sion. In the course of debates on the subject, the attention of the members of the Polytechnic Club was attracted to the feasibility of combining a guaranty with the inspection, thus giving both parties to the contract a pecuniary interest in the safety of the boilers. On account of the Civil War the idea waited several years for further development.

No one man did more, or possibly as much as did Mr. J. M. Allen, in organizing the Hartford Steam Boiler Inspection & Insurance Co. Through his efforts, and those of his associates, the State of Connecticut issued a charter to the company in May, 1866, empowering them to inspect steam boilers and insure the owners against loss or damage arising from boiler explosions. You will pardon me if I pay a slight tribute just here to Mr. Allen. He was a man of commanding appearance, big in body, and likewise in heart, generous, simple in his tastes, strong in his convictions, and a most approachable man. He was loved by all the employes of the company, and when he died every one felt that he had lost a friend. The company (the first to write boiler insurance in the world) was launched in November, 1866. Mr. Allen became president of the company in 1867, and remained in that office until his death, Dec. 28th, 1903, and he was about everything from president down to the office boy. The company was more than once threatened with an early death, and it took many years of education to place the company on a substantial footing.

It is not necessary to go into the early struggle for existence, for the importance of boiler inspection and insurance was established years ago beyond question, but we might take up the evolution of the business. In the first place, rates were based on the pressure carried,—60 lbs., 1 per cent.; 70 lbs., 1¼ per cent.; 80 lbs., 1½ per cent.; 90 lbs., 1¾ per cent.; 100 lbs., 2 per cent. annually. Specific lines were placed on boilers, engine, and machinery and buildings, life and injury being eliminated. Boiler plates were then made of iron, and on rare occasions in this day and age we find an iron boiler built many years ago. They knew very little about boiler construction those days compared to methods used by builders of today, though there is still room for improvement, as Mr. Foord will demonstrate later on—taking up the lap seam.

The first policy blanketing property, life, and injury, was written in the '80's, the limit of $1,500 on any one life, which usually covered the engineer and fireman. In a few years (about '85 or '86) the company began writing term business, increasing their lines with fear and trembling, the policies then covering any person or persons up to $5,000 limit. The increase in business soon justified their action. Boiler insurance rates today are primarily based on inspection cost, the expense ratio being 83 per cent. average for the past ten years, and our loss ratio about 10 per cent.

If boilers, upon inspection, do not come up to a safe factor, we would not write a policy on them for any amount of premium, though we have incurred an expense, we do not charge the applicant anything in case we refuse the boilers. This expense, by the way, is a large item, and you will be surprised at the number of boilers that are rejected every year. Some steam users take chances which I consider criminal.

Out of the total number of defects found in total number of boilers inspected, 10 per cent. are reported dangerous, which in itself shows the absolute necessity of boiler inspection. The nature of defects found are as follows:

There are three states which have laws governing boiler inspection—Massachusetts, Minnesota, and Indiana. In these states the steam user is exempt from the cost of state inspection, provided his boilers are regularly inspected by companies authorized to do business in those states. I believe most all large cities have ordinances governing the same—Chicago for instance—but here the steam user is not exempt, and it would be useless to try to pass an exemption act, for reasons which it is not necessary to mention. We have statistics of the number of boiler explosions during 25 years between 1879 and 1904. There were 6,769 explosions during those years, which resulted in the death of 7,295 persons, and more or less injury to 10,868,—a total number of persons killed and injured, 18,163. Many a city has a population not materially greater. We have no record of the property loss, but estimated on an average of $5,000, which in our experience is conservative, it would amount to $33,845,000. There are three elements entering into our business that tend to avert the natural growth.

In the first place, electrical power is being distributed more or less from central power stations, gas and gasoline engines are being perfected more and more to develop greater horse power, and larger units are being installed every year,—by this we mean the water tube type of boiler, which is being built to develop 250 to 500 horse power. The water tube boiler was originally called a "safety boiler." The word "safety" is a misnomer (so far as this type of boiler is concerned) and has been *exploded* many times. One of the strong talking points of the salesman in selling this boiler, was that they were absolutely safe, and it would not be necessary for the buyer to pay a premium for boiler inspection and insurance. Some of the most disastrous explosions have been caused by this type, and we have yet to find any boiler that is absolutely safe when operated under high pressure. Out of twenty boiler explosions we find there is but one in the twenty that explodes under proper inspection. We cannot guard against carelessness.

A little knowledge is sometimes dangerous. A certain man in this town whom I talked to some years ago regarding boiler in-

spection, was operating a number of boilers, in several different plants. He seemed to know really more than all of our inspection force put together about the way to handle a boiler. He asked me to go out and see his plants. I told him I was not a boiler inspector; that I could not tell anything by looking at his boilers, but still he insisted upon my going out and seeing them. I looked at them, and he told me how they were set, etc. and when he got through I said, "Well, now, I have taken your time but from what you have told me, under our rules we could not insure your boilers and consequently there is not any use of our talking about it." About two or three months after that that boiler exploded and killed a number of people. I would not attempt to give you the cause of that explosion, but I think the way he operated it had something to do with it.

Another man, living in this city, had one of his boilers explode and he was in the hands of the custodian, the charge being criminal carelessness. In speaking of the causes of explosions, it seems to me there is something very mysterious about some boiler explosions. There are some explosions that take place which it seems cannot be explained either practically or theoretically. In this case I remember experts were called before the Judge and their views differed about as much as the views of physicians trying a man for insanity. Steam has never been analyzed; we do not know what electricity is, except we use the force and energy of electricity.

I feel I ought to draw this to a close, because you will be more interested in mechanical lines. You understand that our talk is more along the stationary line of work. We have no slides showing locomotive boiler explosions; we have some views in our office of locomotive boilers that have exploded and what is left of them, but have not had time to make the slides and we are very sorry not to have them here, because you gentlemen are railway men, but perhaps at some other time we may give you some views of locomotive boilers that have exploded. I thank you, gentlemen, for your kind attention.

THE PRESIDENT: Gentlemen, I have pleasure in introducing Mr. J. S. Foord.

MR. FOORD: These photographs or pictures that we will show tonight I have taken myself, with the exception of the last one that was taken in Massachusetts.

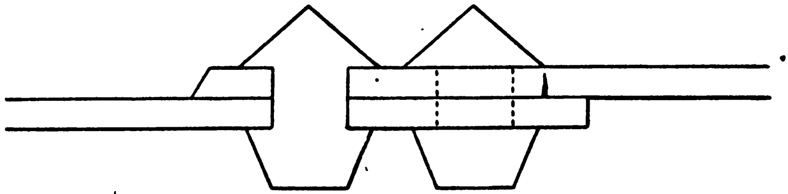
PRESIDENT BENTLEY: Mr. Foord will appreciate it if you will make mental note of any question you may want to ask him and at the close of his talk he will be glad to answer them to the best of his ability.

SLIDES.

MR. FOORD: The first slide shows a boiler inspector, ready to make an external and internal examination of the boiler. In nearly

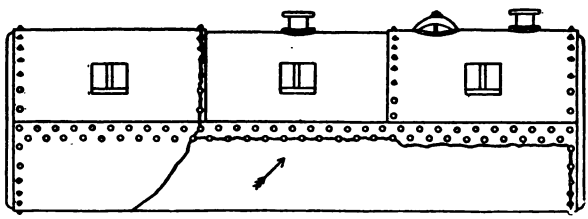
all the fire tube boilers you will find a manhole plate in the bottom directly over the fire, also one at the top. In some cities the local laws compel all steam boiler manufacturers or steam users to have an opening large enough in the bottom of the front head to allow the inspectors to examine the plates on the inside of the boiler. In some cases he examines the tubes of a fire tube boiler by going on the inside of the boiler below the tubes. This gives him an opportunity of examining the tubes and the shell of the boiler on the inside, then following up by the inspection of the outside of the shell and the firebox and combustion chamber.

The second slide represents two plates fractured as we usually find them. I might say that it is rather a hard matter to discover this



SLIDE 2

fracture; usually it is discovered by leakage at the calking edge of the plate, or by a slight crack or hair line which will appear along the outer side of the upper row of rivets. Ninety-five per cent of the boilers were formerly built this way. I have been examining boilers for the Hartford Company since 1886, and in all my examinations I never found a plate that was cracked along the longitudinal seams, so you can see it is a hard matter to find, although we do have in our corps of inspectors, cases where that crack is reported. I had one last week which was reported from a little town in a Western state. The inspector found that the plate showed leakage along the longitudinal seam and our instructions are to be very careful when anything of that kind is reported. In making the examination he found the plate had started to crack and found a hair line along the rivets, not in the weakest part of the plate. You can see by this slide that there is not a rivet hole in that entire



SLIDE 3

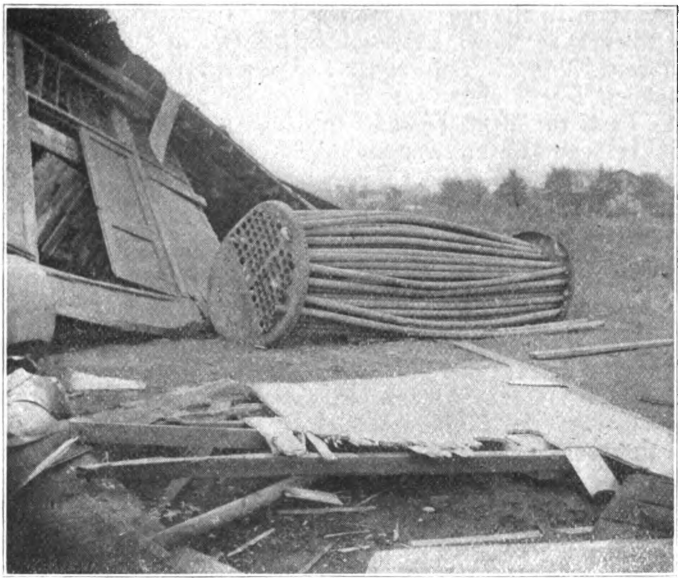
plate shown in the fractured edge. I have that piece of plate in the office and there is not a single part of the fracture which caused

this explosion in the net section, or the weakest part of the plate.

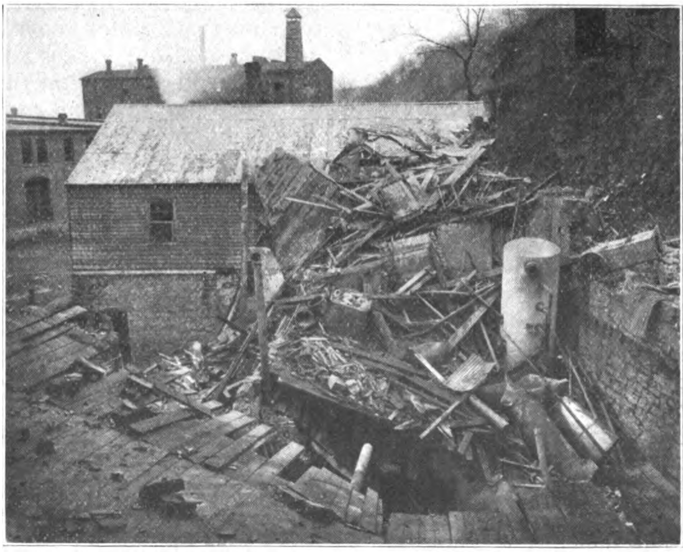
The third slide shows explosion of a boiler at Buffalo, N. Y., at the Glucose Works. This boiler was one of the continuous seam type, which I will show you later on, the longitudinal seam extending from the front head to the rear head. Apparently when this boiler was built it was impossible for the manufacturers or builders to get a plate the entire length, which was 16 or 18 feet, and built a boiler using one plate for top and bottom, using a dome. This boiler exploded and the plate ruptured the entire length of 16 or 18 feet, ripping out, not in the net section, but in the plate right above it.

Slide No. 3 shows a boiler which a few years ago was looked upon as being one of the best that could be designed, the builders claiming that on account of having no seams exposed to the fire, it was less liable for sediment to settle on it and therefore made an ideal boiler. It was impossible on the larger size boiler to design a longitudinal seam high enough up to be out of the fire, and in the majority of cases the longitudinal seam would be about 18 inches below the fire line. The slide shows the internal fracture along the longitudinal seam in the centre. In nearly all the explosions that we have had, with the continuous longitudinal seam from head to head, the initial rupture has taken place in the centre. I was talking with a gentleman here tonight who asked me if I had had an opportunity of seeing an explosion that took place at Paxton, Illinois. I distinctly remember it and I have some photographs that I took of it, but in that case the boilers were of the two sheet variety, one sheet on the top and another on the bottom. The initial rupture was along the center; in some cases the plate had broken through and with the aid of a micrometer you could not detect that the edge of the plate where the fracture took place had been reduced a particle, both edges measuring up exactly. The initial fracture ran along about eight or ten rivets, dropped down into the net section going along about as many rivets and then up, but the initial fracture was along the center. Usually the rupture taking place will be on one side, although I have seen some when they exploded, the bottom sheet of the boiler, going down and the top sheet up, the bottom striking the bridge wall and indenting it so that you could almost count the brick, the force being so great.

Slide No. 4 represents a composite picture of the explosion of a two sheet boiler. Probably out of twenty-five photographs that I have of tubes that have blown out you will find the tubes still on the heads. I have some photographs of two explosions that took place in Michigan, in a large paper mill. The brick stack is now fitted with angle irons that were put on to protect the stack after the first explosion. When the second explosion took place the tubes and head were thrown out within ten feet of where the first ex-

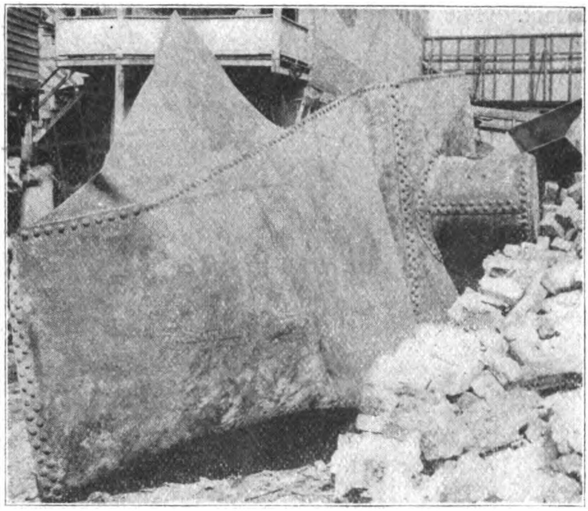


SLIDE 4



SLIDE 5

plosion occurred, and the shell of the boiler in the same position as the first one.



SLIDE 6

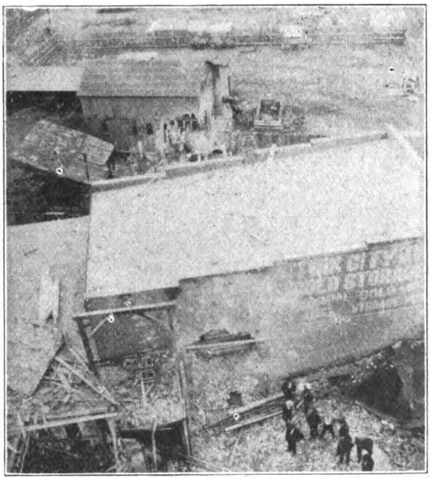
Slide No. 5 represents the wreck of a soap works in the city of Dubuque, Iowa. The boiler lies down in the bottom of this wreckage. The dwelling house where the engineer lived was moved away bodily about 18 inches by the force of the explosion.

SLIDE 7

Slide No. 6 represents a sheet on a boiler that exploded here in Chicago. A great deal of comment was made about it at the time. The slide shows the longitudinal seams from the first to the rear girth seam. The seam and the rear head are shown, the two braces below remaining intact and several of the upper braces also re-

maining intact. The rear head and the tubes were torn out by the explosion.

Slide No. 7 shows a view of the building after the explosion.



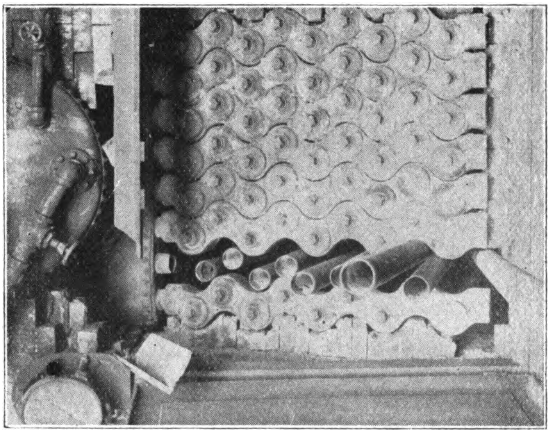
SLIDE 8

Slide No. 8 is a rather poor view of the cold storage plant at Champaign, Illinois, which many of you may have seen and which was wrecked by a boiler explosion a short time ago.

SLIDE 9

Slide No. 9 shows the boiler after it traveled 125 feet. The boiler was 60 inches in diameter, 16 feet long, and, as you will see, nearly all the tubes remained in the rear head. The boiler went

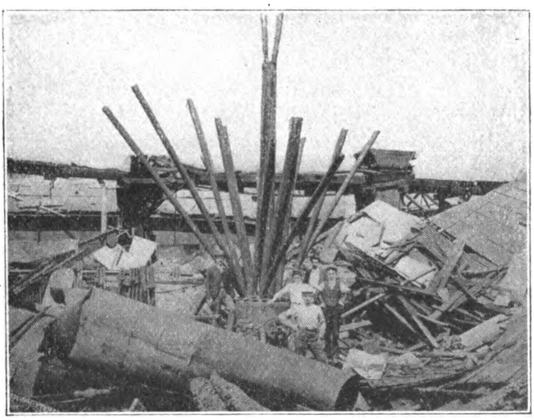
through the brick wall, through a center partition, through a brick wall on the other side of the building, a building fifty feet wide, crossing a yard fifty feet wide and landing in the corner of a



SLIDE 10

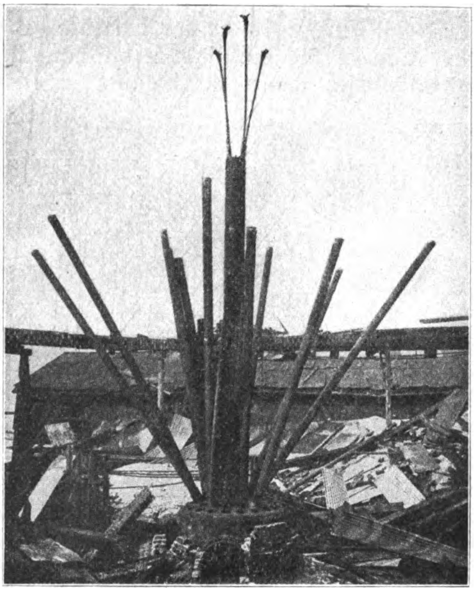
barn. What few tubes were pulled out of the heads were thrown so high, that on striking the gravel roof of the old storage house and also the roof of a five-story building, they were forced through the two-inch roofing

While we were looking over the scene of the explosion, we dis-



SLIDE 11

covered that a large piece of roofing felt was lying on the top of the chimney which was 105 feet high. A few weeks previous to the explosion they had put a new roof on the boiler house and the pieces



SLIDE 12

of the felt roofing which were very heavy and covered with gravel were found lying on the top of the chimney. It was necessary before we could start a fire after the new boilers were installed to go up and remove the felt from the top of the chimney.

We had an explosion a short time ago in an Indiana town where they had a sheet iron stack on the boiler that exploded. The stack was 48 inches in diameter and probably 125 feet high. About twenty-one feet, or seven sections,—they were three-foot sections—were thrown on top of this chimney. On the top of the chimney were bolts holding down the cap, and they had been forced through this quarter-inch plate, so as to hold the plates securely.

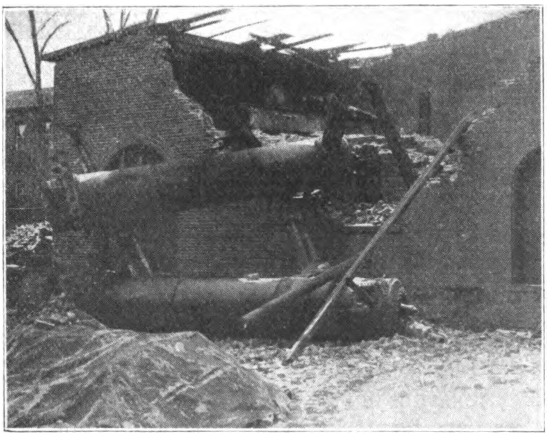
Slide No. 10 represents a water tube boiler, in one of the neighboring towns of Chicago where the tubes which we contend should be flared, were not flared at all and the head flew off, went through the roof, but fortunately did no harm. I was there in a few hours after it happened. This shows that our safety boilers are not always safe.

Slide 11 represents a vertical type water tube boiler. This was in one of the large iron works in Pittsburgh, the upper end or steam drum corresponding in diameter to the lower one, but longer and weighing considerably more, weighing probably two tons. This steam drum was thrown nearly a mile. We had one of this same type explode about a year afterwards and by actual measurement it went three quarters of a mile, landing in a street, and

bounded back along the middle of the street, tearing up places where it struck probably two feet deep. These tubes you see spread out here extended from the lower head to the upper head,

SLIDE 13

or lower part of the upper drum, the upper drum extending from the central tube, about 18 inches in diameter, to the top of the brace. When this drum went off from the lower part of it, it pulled out from this upper end of the central large flue, leaving four braces extending from the head to the central flue.



SLIDE 14

A Member: What was the cause of that explosion?

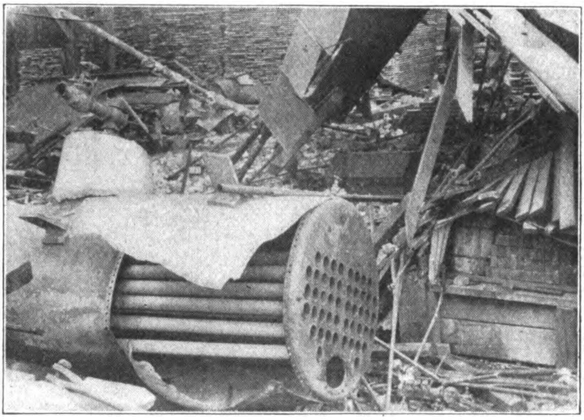
Mr. Foord: It was low water.

Slide 12 is another view of this same boiler taken at another angle and shows the parts of the flues and furnace.

Slide No. 13 shows an explosion of another water tube boiler which happened in New Jersey. The tubes shown represent the tubes at the rear end, and the forward end of this same drum was connected to the nipples that we see extending through to the headers on the front.

Slide No. 14 is another view of this same explosion showing clearer the tubes at the rear and the cross box that connected the drums with the tubes in the lower part of the boiler.

Slide No. 15 shows, strictly speaking, a low water explosion. In nearly all of the explosions that we can trace to low water we can find that the plate ruptures about 18 inches from the bottom of the



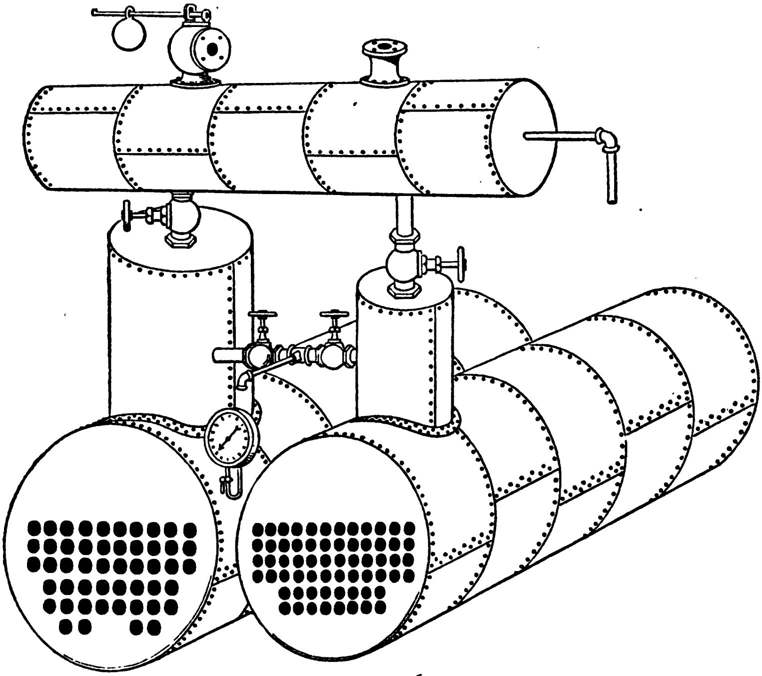
SLIDE 15

boiler. In this case it has parted between the lower row and the next one above it. This was in a ship plant on the Ohio river, near Cincinnati. A feed pipe of the boiler froze up; the water kept getting lower through evaporation, until finally the plate overheated, could not withstand what little pressure they had in the boiler, and the section extending from the first seam to the front head had reduced in thickness until it was almost a knife edge, and that represents probably eight or ten low water explosions that I have investigated within the last two years.

Slide No. 16 represents something you find usually in the sawmill districts. You will notice the boilers are not alike and the one boiler has a larger dome than the other. I know if there is a boiler maker here he would hesitate a long while before putting a dome on in this way. On this there is a valve for the steam supply on the top of the dome of each boiler and possibly he believed if he had trouble with one, he could use the other. In this case they placed the safety valve on the top of the cross connecting drum with stop valves between it and the boiler. The worst explosion we ever heard of was one where the stop valve was found

between the safety valve and boiler. I remember visiting a plant at one time where the boiler makers had been making some repairs to a boiler and did not disconnect the cast iron neck connecting the top of the dome to the piping; steam leaked through from the other boilers and to prevent this leakage he drove a large wooden plug in the neck, connecting them up, and forgot to take it out and when they investigated the wreck they found this large plug, possibly six inches in diameter, driven firmly into this neck, cutting off all possibility of the safety valve being able to do its duty.

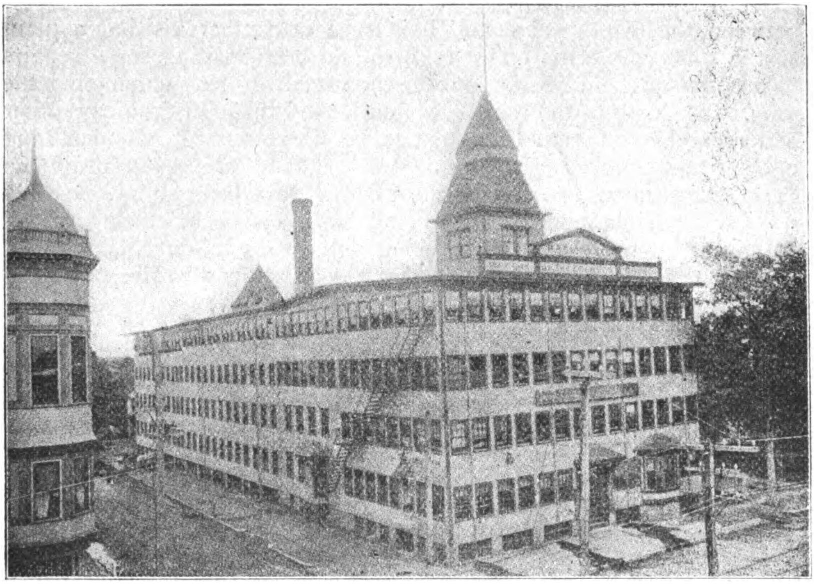
Slide 17. In this series of slides I shall show you the wreckage



SLIDE 16

of the original building and the results of a boiler explosion and fire at the Grover Shoe factory, Campello, which is one of the small towns near the great shoe making city of Brocton, Mass. I had inspected the boiler that exploded several years ago when I was in New England and was quite familiar with all the surroundings of this plant. This slide shows a general view of the office wing taken sometime before the explosion.

Slide 18 shows the general plan of the street, the location of the buildings that surround it, the engine house, the little shop, etc. There were two boilers in this plant, known as No. 1 and No. 2. The No. 1 boiler was the old boiler installed several years before,



SLIDE 17

the No. 2 boiler was a new one and abutted on what is known as Calmar street and was at right angle to Denton street, the Denton street wing being about twenty feet distant from the shop portion. This shows the number of buildings that were actually destroyed by the explosion of boiler No. 2. The shaded part of the building was destroyed by fire which took place after the explosion. The dotted line shows, the flight of the boiler from where it originally stood over to the Hood house, passing the house of Engineer Rockwell who had charge of the plant and was killed in the explosion.

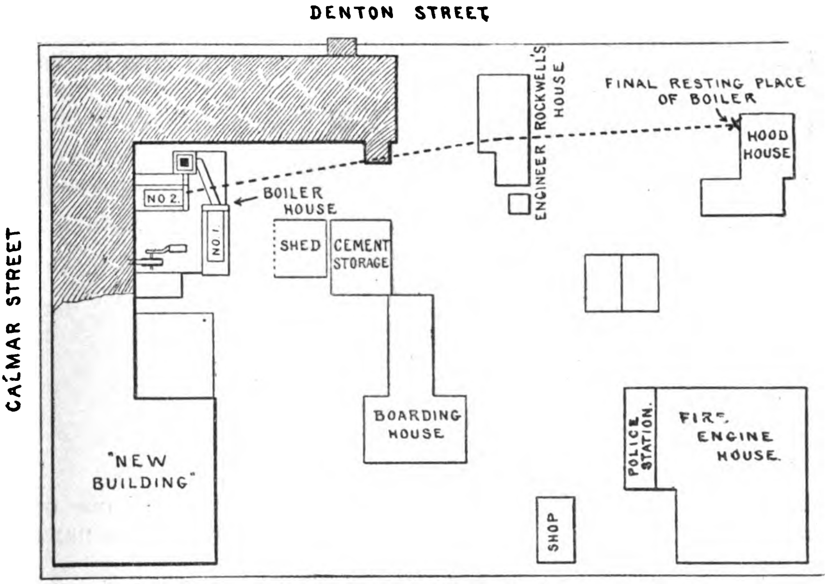
Slide 19 shows the course of the boiler from the building that it was originally in, the boiler passing through the engineer's house, wrecking the forward end of an express wagon, landing here and then bounding over and striking the Hood house. That house was an ordinary building of probably eight or ten rooms and the force of the boiler striking it in the lower part moved the house bodily about 18 inches off its foundation.

Slide 20 represents a boiler somewhat similar to that one that you saw, the explosion of which took place at Champaign. One peculiar thing we noticed was that the tubes are smaller.

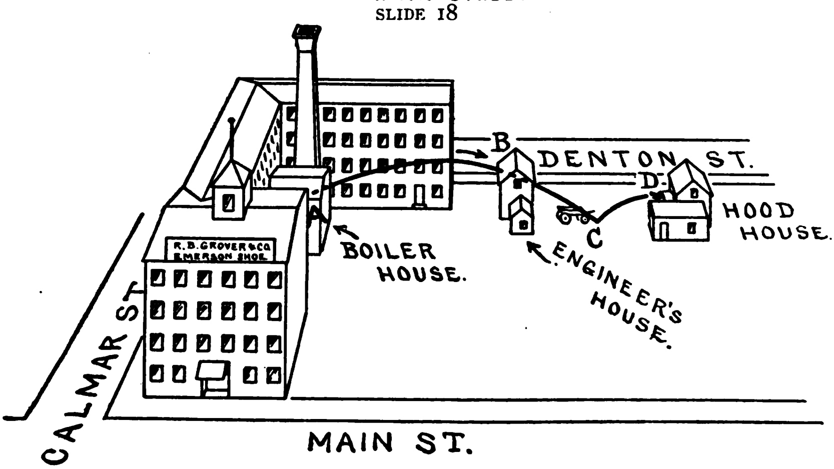
In the East we find, on account of better grade of coal they use, a smaller tube gives better results, the majority of them being three inch tubes. This shows the front sheets of the boiler. I might say that the initial rupture of this explosion was along the longitudinal seam, precisely as the first picture we showed.

Slide 21 shows you a general view of the wreckage. There were

about 200 persons at work at the time the explosion of this boiler took place; there were 58 killed and 117 injured; most of the bodies in the ruins were burned and the only way of identification was by the aid of buttons or trinkets found with the bodies.



SLIDE 18



SLIDE 19

The property loss of this kind is a hard matter to determine and fix, but from the best of our ability, our estimate would be about $200,000 on account of machinery and plant, for at the present

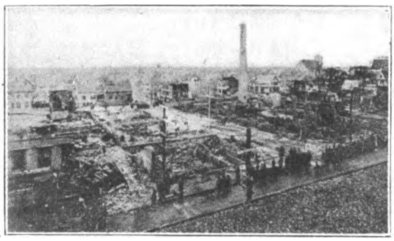
day some of the machinery that is used in shoe factories is quite a delicate mechanism for sewing and pegging and making the different parts. The immediate property loss probably on this was, as near as we could fix, about $80,000, for the building.

Slide 22. While this is not a boiler, I presume will show graphically the progress that has been made in the line of higher pressures, higher speeds and improvements, the large one represents marine

SLIDE 20

engines in 1872, developing 1,000 horse power; the small one on the right, built in 1892, shows the same horse power but is much smaller in size.

Slide 23 represents one of the sixteen boilers that the steamer "Deutschland" was equipped with. This boiler is sixteen feet six inches in diameter, and the entire heating surface of all the boilers on the vessel is about an acre and three-quarters. That shows you



SLIDE 21

what is probably now the largest boiler plant on a vessel. What the newer ones are bringing out I do not know.

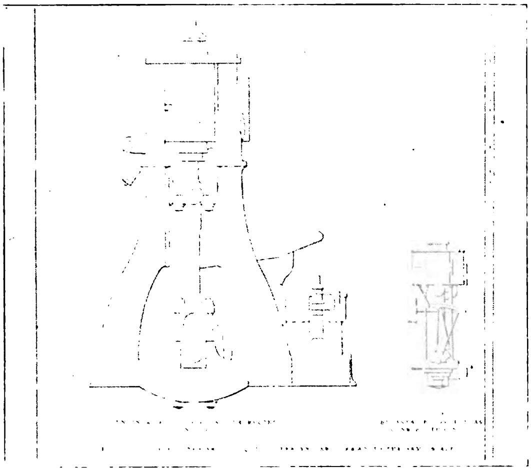
In speaking to you a while ago I called your attention to the caulking edge of an outside strap. It is absolutely necessary in this case, on account of the plate which is over an inch in thickness, to bevel off the edge and caulk same to make the joints tight. If they had used a strap of the same width as the inside one, it

would have been impossible to make the joint tight. One of the main points in carrying this out so far would be that it stiffens the plate and make a better joint. That concludes the views.

A MEMBER: What is the boiler pressure?

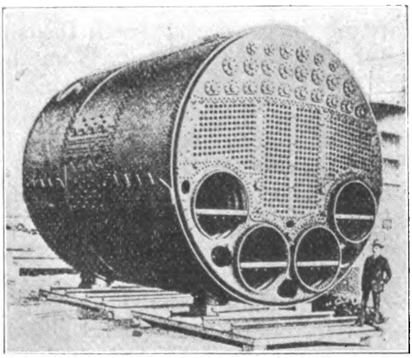
MR. FOORD: One hundred and ninety pounds pressure is used on this boiler.

PRESIDENT BENTLEY: The subject tonight has been a very in-



SLIDE 22

teresting one, and knowing as I do, that we have so many members who have the care of boilers, it shows very graphically the necessity for proper care and inspection. There has been in the



SLIDE 23

past—a good many years I hope—a belief and feeling that it was all right as long as it did not go up. Now, the tendency is. and

rightly so, to do everything that we possibly can to take care of it and keep it in good shape so that we absolutely know it will not go up. One of the most distressing things, I think, is a boiler explosion, and investigations on this subject bring out things that cause a very uncomfortable feeling to the people who have the care and charge of those boilers, so that I can only suggest to you, gentlemen, that great stress should be laid on the proper inspection and care of boilers, and err on the side of safety and greater stringency of regulations rather than the reverse.

The hour is getting late, but Mr. Foord has kindly consented to answer any questions, and if you will ask him briefly, I know he will be glad to tell you what he can. But before doing so, our Secretary will read a discussion by Mr. Symons, who was unable to be present.

Mr. W. E. Symons (communicated): I regret my inability to be present at the Club meeting tomorrow night. The Club is very fortunate, however, and is to be congratulated in securing Mr. Foord's consent to prepare and present a paper on so important a subject as boiler explosions. The reputation of the Hartford Steam Boiler Inspection and Insurance Company and also its representatives is such that they are looked upon as authority of a higher order, and doubtless Mr. Foord's presentation of this subject will add to their present reputation and prestige in the Engineering world.

The subject is such a broad one that regardless of the information brought forward both of a theoretical or practical character there always will be many debatable points and unsettled questions between persons well qualified either by theory or practice to analyze the subject from its various standpoints with a view of reaching a conclusion both as to the cause of, and a remedy for Boiler Explosions.

There are a few points in connection with the subject that have occurred to the writer and if the same have not been referred to by the author of the paper, I will beg to ask his consideration of them.

First, as to what are considered the most tangible proofs of boiler explosions in the way of evidence taken from or resulting from a personal inspection of the ruptured plates, broken stay bolts, braces, rivets, etc., together with their discoloration indicating certain heat temperatures and conditions,—the latter feature or condition in particular indicating in a rather close and reasonable degree the existing water level at the time the explosion occurred. Also about how many minutes or seconds of time would elapse after a crown sheet was exposed to the ordinary fire before the sheet would become soft and plastic, thus permitting it to either come down or as might be termed the boiler to explode. This calculation first to be based on a radially stayed internal fire-box of the locomotive

type, stays threaded their entire length and screwed in from the outer sheet and the inner ends peaned or beaten over cold. The second calculation or consideration to be based on the same conditions, except that six or eight of the central rows of radial stays are to be provided with what are called large or button heads, the bolt to be inserted from the inside of the fire-box. The third consideration is to be based on a fire-box supported (crown sheet) with crown bars, the crown bar bolts to be provided with large or button heads and driven up from the inside. These several calculations to be considered also with three different kinds of fuel, bituminous coal, anthracite, and oil fuel; also at different steam pressures—say from 150 pounds pressure per square inch to 225.

I would also suggest the consideration of the difference between a clean boiler and one with various degrees or quantities of scale and sediment—either soft or hard, and especially pointing out the negative effects of a heavy coating of hard scale, both on the fire-box plates, stay bolts or braces, and is not scale formation of this character in large quantities considered injurious alike, both to the plates and the staybolts in that the transmission of heat units decreases in proportion to the thickness of the scale, while at the same time the plates slowly become burned, which not infrequently results in its cracking,—these cracks usually radiating from the stay bolt holes where the stay bolts are heavily covered with scales.

This particular feature of boiler weakness, however, is confined largely—if not altogether—to points so far below the water level and near the live fire line that the consideration and treatment thereof would be separate and distinct from the question of crown sheets coming down on account of low water or boilers exploding on account of weakened condition of plates resulting from overheating in the case of absence of water.

The difference in the behavior of water showing various chemical analysis, both before and after treatment, and under various steam pressures, and also whether it is considered necessary as a matter of boiler protection to apply any compound or any other treatment to water in boilers that have been mechanically treated prior to entering into boiler, I beg to suggest as quite essential to a proper presentation of the case.

There are at times well authenticated cases of boiler explosions where there seems to be an entire absence of any evidence either practical or theoretical as to the cause thereof. Some of these occur with a very low steam pressure, indicating the possibility of there existing at times an element or a combination of elements which might be termed a highly explosive and powerful gas, which under certain conditions assumes the form and operation, and strength of a bomb. A case a few years ago coming under the writer's notice was of a new locomotive boiler less than 12 months old being damaged by some kind of an explosion at a time when

there was less than 60 lbs. of steam pressure. The steam gauge could not have been out of order and falsely indicated for the reason that in their efforts to get the engine from the round house with throttle wide open it required the assistance of a half a dozen men with pinch bars, which is conclusive proof of low steam pressure. There was ample water (about three gauges) as the crown sheet did not suffer any injury whatever—simply the flue sheet was blown or forced about four inches from its true position by the force of the explosion—thus leaving the back ends of the flues unsupported and allowing the water from the boiler, together with what little steam it contained, pass out in the fire-box.

Another rather strange phenomena in connection with the behavior of boilers is the burning of plates either crown or side sheets when the water level is above the crown sheet and there is no appreciable amount of sediment either on the crown sheets or side sheets, it being claimed that by excessive firing, especially with oil fuel when the water level is reaching the lowest conservative point, that it is possible to force this thin sheet of water away from the crown sheet and burn it. Side sheets it is claimed suffer in a similar manner due to excessive firing, lack of sufficient water space and the character of the water, some waters being more easily disturbed by heat than others.

The question of draft—Cold air on flues plates, etc., is also an important one.

There are numerous other questions and phases of the subject which I would be glad to present, but I feel that others who attend the meeting can not only present the points which I have touched upon, but all other features of the question much better than myself.

H. T. Bentley: It will probably take up too much time to give Mr. Symon's communication the attention it deserves, and I would suggest that the matter be turned over to Mr. Foord and give him an opportunity to reply in writing so that it may be embodied in the report of our proceedings.

If there are any questions we will be glad to have the members ask them.

Mr. J. W. Kelly (C. & N. W. Ry.): I would like to ask a question in regard to the case cited where, after careful investigation of the boiler it did not show any reduction in the plate that cracked along the rivets. I would like to ask what caused that explosion.

Mr. Foord: There is always more or less of a movement in the bending of the plate. You get a pressure on your boiler of from 110, to 140 pounds, and there will be a movement at the seam, or rather where the sheet strikes on the beveled part of it. It is the same as a shaft; a shaft will usually break off close to the box where it is supported; it is absolutely solid, and

there must be some movement of the plate and that is transferred to the part of the plate adjacent to where it cannot move, and the bending back and forth of this metal where it is lapped over, causes a strain on a line, not the weakest part of it, but just above it. You might represent it with your hand, bending back and forth from the knuckles. It cannot bend where the plates are riveted together, and it is transferred to the plate nearest that part and the bending back and forth of the metal breaks the fibers, and in time it makes a fracture.

MR. IRA M. HUBBELL: Do the fractures show crystalization?

MR. FOORD: Usually they do.

MR. KELLY: I would like to ask if in a steel boiler that was tested?

MR. FOORD: In steel boilers, and in nearly all the explosions that have taken place some one will test the plates, take strips out as close as possible to where the plate fractured, and the result has been almost uniformly that the plate is up to its usual tensile strength, ductility and so on, but the movement back and forth of the plate causes it to segregate or separate along a line that has been weakened. The bending of the plate is the same as taking a piece of tin and bending it back and forth. Some plates are a great deal more susceptible than others. I had one of the men in one of our large fire boxes strike a sledge hammer blow and he found that plate cracked about 18 inches in the solid plate, there being no reduction whatever in the thickness of the plate.

PRESIDENT BENTLEY: You say you have a sample of that in your office. I think if you will ask Mr. Kelly he can give you a few hundred of that kind. It is a very common occurrence to have sheets crack when any hammering is done, especially when the boiler is cold.

MR. FOORD: We usually bring back samples and specimens; I have quite a large number of them. We have a large field with probably sixty inspectors; they naturally run across a good many curious things and send them in, because in an accident we usually have what is left.

MR. E. W. PRATT (C. & N. W. Ry.): I would ask in regard to the grooving and pitting of boilers. You have shown no illustrations of the explosion of boilers as the result of grooving and pitting, I would like to know whether you have had any experience along that line in stationary practice?

MR. FOORD: Why, we have received quite a number of reports on grooving and pitting. It is usually due to the improper design of the boiler, that shows one part of it is antagonistic to the other. In some cases you find some parts of it near a seam or flange where the metal has worked back and forth close to the seam and it is grooved, apparently the skin of the metal has been broken, and there will be some sort of acid, corrosive matter in the feed water

which will work on the plate where the skin has been broken. I have run across quite a number of bumped heads in large steam drums the same as I showed you. We found one where the entire head had grooved, possibly two-thirds of the thickness in the heel of the flange. Possibly the plate was a little off on chemical analysis; that I do not know. In regard to pitting, we have quite a lot of that in different boilers, but the feed water has been found to be the principal cause of the pitting.

MR. PRATT: Do I understand your head fracture usually starts from the outer surface of the pit?

MR. FOORD: Usually, because the plate on the outside is in tension. When you roll a piece of plate—you have the outer side in tension, while the inner side of the plate is under compression.

PRESIDENT BENTLEY: Professor Goss can we ask you to say a word or two on this very live subject?

PROF. W. F. M. GOSS (Purdue University): I have had very little experience with boiler explosions. A story is told of Mr. William Sellers that has always interested me There was a time, you know, when people were wont to assume that a boiler explosion was necessarily surrounded by mystery; that something which nobody could explain was responsible for the explosion, and at one of the meetings of the Engineers' Club, perhaps it was in Philadelphia, this subject was under discussion—this was quite a number of years ago, and some one asked Mr. Sellers whether he had a theory which would explain the explosion of boilers and he said he had. He was asked if he would not kindly consent to explain it, and he replied that his theory was that boilers exploded because the pressure inside was greater than the strength outside. (Laughter.)

PRESIDENT BENTLEY: Are there any other questions before we close the subject? Mr. Foord will answer the communication of Mr. Symon's in writing. I think it would be in order to propose a vote of thanks to Messrs. Chriswell and Foord for the very entertaining lecture they have given us this evening.

The motion was made and duly carried.

MR. FOORD (Communicated): Referring to the communication of Mr. W. E. Symons regarding boiler explosions, their causes and prevention, it is as Mr. Symons states, a very broad subject, and it would take more time than we have at our disposal to take up all of the points that naturally would be brought out in a discussion of this kind.

Taking up the first point that Mr. Symons refers to,—what would be considered the most tangible proofs of boiler explosion, in the way of evidence that we have obtained from our inspections, we have, as he states, ruptured plates, broken stay bolts, and defective rivets.

In the case of ruptured plates, the majority of the explosions have

been caused by defects which develop under the rivet heads, and in close proximity to the net section of the plate, near the longitudinal seams. These are defects that can be remedied by using butt strap joints, where a true circle can be obtained, with a greater percentage of strength, and the use of the lap plates obviated. Ruptured plates are practically impossible to detect, except after the plate has opened enough to show leakage on the outside, or to show the lines of fracture on the inside.

Broken stay bolts have been the cause of some explosions, but we believe if a thorough examination were made this defect could be detected.

In regard to the length of time that a crown sheet, exposed to the ordinary fire could be used before becoming soft and collapsing, I have had no opportunity of determining this point, but I believe it would be a very interesting subject to consider with reference to locomotive fire-box boilers, where the crown sheets are stayed with radial stays, and stay bolts threaded their entire length and screwed into the outer sheet, and the inner ends peaned over cold, with two whole threads extending through the sheet. Also take up the locomotive fire-box where it has radial stays with buttoned heads in the fire-box, secured in the usual way; also with the crown sheet supported by crown bars and crown bar bolts.

The question of scale or deposit on plates, exposed to the direct fire of the furnace, and the length of time that they could be used under heavy fire, is one that varies considerably. We have seen boilers with a thick, porous scale that have given no trouble, while others with a thin, hard scale have caused trouble on account of the plates becoming overheated. The reason for this I believe is on account of the density of the scale, preventing the heat passing through same, thus allowing the plate to become overheated, as the water is not able to protect it.

As to the difference in feed water used under various steam pressures, we believe that this is a point which needs more than ordinary investigation; for instance, in some localities water is used which gives practically no trouble in boilers, while considerable trouble is experienced in keeping seams tight, and small leaks rapidly become large, due probably to the presence of acids in the water. In other places a slight leak will cause no trouble, except from corrosion that would take place, on account of the plate being moist.

The case to which Mr. Symons calls attention, where a boiler exploded in a round-house, the boiler being less than a year old, and where the pressure was not greater than 60 lbs., might have been due to the fact that the tubes were not of sufficient strength to hold the head. Then again, there might have been a defect in the head, such as frequently is found. For instance, we were examining a boiler of the fire-box type that had been in use about three months;

when the inspector was in the fire-box, making a hammer test, he struck one of the side sheets, when he heard a noise on the outside, something like the discharge of a gun. An examination showed that the front sheet, directly underneath the fire door, had ruptured for a distance of about 18 inches; this plate was cut out, and the thickness was found to be the same as that of the plate originally, showing no reduction whatever along point of fracture. Furthermore, this fracture did not extend from rivet hole to rivet hole, nor from stay bolt hole to stay bolt hole, but was through the solid plate, and did not touch a hole in its entire length. We believe this was due to a defect in the metal, which could not be detected, but gradually developed after boiler had been put into service, and subjected to strains.

In regard to the burning of plates, either crown or side sheets, when the water level is above the crown sheet, and there is but little sediment on same, I have known of boilers of the fire-box type, which have been repaired, and used on a short run of say 150 miles, which acted badly on their way out, foaming considerably; after reporting to the round-house, boilers were washed out and started for home. After they had been out, on the return trip probably 25 or 30 miles, the crown sheets collapsed. This, I believe could be accounted for on account of considerable oil, which contained animal fats, that was used by the boiler-makers,—they not restricting themselves in the amount that they used, and considerable oil was left in the boilers after repairs were completed. The oil, floating along on top of the water in the boilers, caused them to foam, and when they were washed out, and the water was drained off, the oil, naturally having more or less foreign matter in it that was picked up with the feed water, had deposited on the crown sheets, making a thin coat on them. This thin coating of oil and grease prevented the water from properly protecting the plates, which soon became overheated and soft, and pulled out of the supporting stay bolts.

Also, in regard to side sheets burning, which are located below the water line, and below the crown sheet, we believe that the oil carries down and a great many times causes them to overheat. We also believe that the water space is sometimes limited, so that when a boiler is exceessively fired, there is not sufficient water space to allow for proper circulation, and the plates become overheated.

The majority of the boilers that we insure are of the stationary type, and I believe that there is a marked difference between the operation, care, and management of stationary boilers, and that of the Locomotive type, and it would be very interesting to take up the questions of care and management of each.

President Bentley: Mr. Foord and Mr. Chriswell, we thank you very much for being here tonight and entertaining us. Now, Mr. Seley, will you kindly give us what you have for us?

The Application of Steps and Handholds for the Protection of Trainmen.

Mr. C. A. Seley: The Members of the Master Car Builders Association have recently received from the Secretary a circular showing the result of the letter ballot of the Association on matters so referred at the last Convention. This circular states that Subject No. 4, "Change in text relating to handholds" was rejected, while Subject No. 5, "Location of handholds on roofs of box or stock cars" was adopted.

The M. C. B. Committee on Revision of Standards and Recommended Practice felt that the Standards for the Protection of Trainmen were not satisfactory, judging from the result of the letter ballot and also from correspondence received from members on various phases of the subject.

Your humble servant was delegated to dig into the matter and present to the Committee an analysis and recommendations, which was done. The Committee has approved the findings and has forwarded them to the Chairman of the Executive Committee of the Association, suggesting that early consideration be given the matter, and if it meets with the approval of the Executive Committee, that the report be distributed to all members as advance information of the report of the Committee on Standards, in order to enable the roads to understand practically a year in advance what is the interpretation of the Standards for the Protection of Trainmen as held by the Committee.

I have been authorized by the Committee to make this report and recommendation public at this meeting of the Club, believing that railroads in this vicinity are in need of the information, to lessen difficulties experienced in interchange. This publicity is not intended, in any way, to prejudice or influence the action of the Executive Committee.

These Standards are the most important ones of the Association, involving as they do, the relations between the railroads and the Government, so that a right understanding is most desirable. The report is as follows:

Status of M. C. B. Standards for Protection of Trainmen.

In view of some uncertainty in interpretating the M. C. B. Standards for the Protection of Trainmen, as noted in some recent correspondence, particularly in reference to the application of steps and handholds, consideration is respectfully desired of the following argument.

A general examination of the Standards of the M. C. B. Assn. for the protection of trainmen shows a number of inconsistencies, as between the written text and the drawings on M. C. B. Plate 19, these discrepancies running back for several years in some instances.

The earliest action of the association in reference to this matter was taken in 1888, but this was considerably amplified and made Recommended Practice in 1893. In the 1896 Proceedings is found the basis of present practice. A special Committee of 11 members, under the direction of the Executive Committee, presented a report that was embodied in circulars sent to all members for an informal ballot (See 1896 Proc., Page 463-6). The formal report of this Committee, made at the convention of 1896, (See Proc. pp. 304-311 and 328-335), with some slight subsequent modifications has been recognized as conforming to the intent and purpose of the law as expressed in the Safetv Appliance Acts.

In 1902, by letter ballot the matter was advanced from Recommended Practice to Standard Practice. In 1905 the Plate 19 was revised, adding notes, etc., but no change of the text was authorized. In 1906 the Committee on Standards recommended some changes of text which were discussed and referred to Letter Ballot, but the result of this ballot has been to defeat the proposed changes of text and the entire matter is therefore as shown in the 1905 Proceedings, as regards text and drawings, except the change of position of roof handhold, which has carried in the ballot and is included in this argument.

The idea of the Interstate Commerce Commission in reference to this matter, as explained by the Chairman of the Committee on Standards, (See page 94, 1905 Proc.) is "to have grab irons on all cars in a common place, that is, regardless of whether it is a flat car, a gondola or a box car, that the trainmen may expect to find a grab iron in a certain place on any car." This should also apply to steps and the principle expressed should rule on all cars which may be considered regular equipment.

Cars which may be classed as "special equipment" may require a modification, but these cars should have the regular equipment of steps and handholds common to their general type and may have such additional equipment of steps and handholds as their owners may deem necessary as a measure of safety. The Safety Appliance Acts do not specify the number and location of handholds, and it has been repeatedly stated that the practice and standards of the M. C. B. Assn. are the guides of the Interstate Commerce Commission's inspectors in enforcing the law.

The "law," in this connection and as referred to in Rule 39 is therefore the standard practice of the Association and should be clear and unmistakeable.

In endeavoring to arrive at conclusions in regard to each point, this analysis will give prior authority to the written text in case of disagreement between the text and the drawing, believing that the expressed intention should rule rather than one implied by drawings that can be variously interpreted. This is in accordance

with a well-kown principle of law which cannot be successfully disputed.

As regards the matter of steps the Committee would consider the paragraph having that caption as authoritative regarding the number of steps on cars. In part, this reads, "Two substantial steps—to be fastened, one to each side sill, next to the corner of the car to which the ladder is attached, on cars having ladders, and to diagonally opposite corners on all other cars,—etc." The omitted and remaining portions of this paragraph do not modify these fundamental principles, which appear in the Proceedings, back for several years. Nothing inconsistent therewith is found in the section under the caption of Handholds, if reference to the drawings is omitted. It is a fact, however, that the drawings as shown on Plate 19, ever since 1896, do not agree with the text and a number of changes were made in the 1905 sheet which are not included or explained by the text.

Back of 1905, the cuts show steps on both sides of the same ends of drop end gondolas, tank and flat cars, whereas they should be shown only on left hand side of end as on box, stock and fixed end gondolas. These views are plainly intended to show one end only in each view, and to be consistent with each other and with the principle expressed as to the number of steps on cars, they should have been eliminated.

The 1905 revision of Plate 19 adds a lot of text to the views. evidently intended for explanation but some of it is manifestly not in accord with the authorized description, pages 456-7-8. Prior to 1905, the car views were marked A.1, A.2, A.3, etc., but these designations are omitted in the 1905 Sheet 19, and as the views are still described in the text by these symbols, it would seem as though the sheet 19 of 1905, as regards Standards for the Protection of Train Men is completely invalidated, or at least very incompletely supplements the authorized text.

This sheet, however, was submitted as a part of the report of the Committee on Standards, was received and ordered submitted to letter ballot, was passed by a large majority and is therefore a Standard, insofar as it is consistent with the description. It was repeatedly stated in the discussion of the Committee report (pp. 91-101), that the changes of the drawings were merely the addition of explanatory notes and of cuts of high side gondolas, not before shown. The Committee's report also included the following: "In the construction of special equipment, grabirons or handholds should be placed on both ends of the car; sill steps and ladder rounds at the B end of the car. If the construction is such as to add an element of safety, they should also be placed on the right hand side of the A end of the car." Inasmuch as the foregoing has to do with "special" equipment which has already been considered in this argument; as there is no authoritative ruling

as to what may be considered special equipment, and as there has been no provision for the incorporation of the Committee's recommendation in the descriptive text, either at the 1905 or 1906 conventions, a new paragraph is hereinafter proposed in lieu thereof, to be inserted in the descriptive text.

In discussing this matter with the Secretary, he suggests that if revision of sheet 19 is made, that the entire sheet be given up to this subject, and other matters shown thereon be transferred to some other sheet; also that the views be made larger and clearer, and that the sides at both ends be shown instead of showing only ladder ends.

It is believed that for consistency, to have plate M. C. B. 19 properly represent what is described and to have the description agree with the Plate and also include what is not now included. although common and general practice in some respects, that the text and the drawings should be changed at the earliest possible moment, in view of the importance of the matter to the railroads as regards their relation with the Interstate Commerce Commission and also to establish a safe and readily understood instruction. To that end, the following suggested revision is substituted for your consideration:

OFFICE OF MECHANICAL ENGINEER, ROCK ISLAND LINES.

Chicago, Ill., Sept. 1, 1906.

PROTECTION OF TRAIN MEN.

Sheet M. C. B.—19.

Introductory paragraphs (1) (2) O. K.

POSITION OF BRAKE SHAFTS.

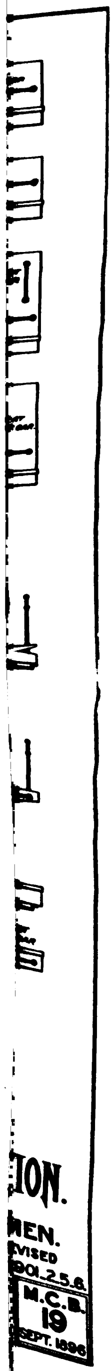
O. K. (The word "about" being put before "20 inches" in last line, in accordance with action last year. Also add Proc. 1905 and 1906.)

Running Boards. Owing to the abolition of buffer blocks in 1904, reference to them in this section is improper. It is proposed to eliminate the words, "so that the end of running board shall not be more than 6 inches back of face of buffer block." It is suggested that location of the ends of running boards be referred to a committee at the next convention. Drawing to be changed by omitting buffer block and measurement.

Steps, O. K.

Ladders. First four lines O. K. The semicolon after the word "car" to be changed to a period and the balance of the sentence changed to agree with the action of the 1906 Convention, as follows:

"Car. Each car to have a handhold on roof directly over top of ladder and running parallel with the side or end of car on which the ladder is located; these handholds to be placed about 15 inches from the edge of the car and of a length suitable to the construc-


ION.
MEN.
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1901.2.5.6.
M.C.B.
19
SEPT. 1896

tion of the car." When iron ladders are used and placed, etc., also lines 8 and 9 O. K.

Proceedings 1902, 1905 and 1906.

HANDHOLDS.

First paragraph O. K. (Reproduce drawing as in 1905 except roof handhold which should be parallel with end. Notes are O. K. Mark A1.)

Second paragraph, O. K. (Reproduce drawing as in 1905. Mark A2.)

Third paragraph, O. K. (Reproduce drawing as in 1905, except roof handhold which should be parallel with end. Notes are O. K. Mark A3.)

Fourth paragraph. (The language of the fourth line, in reference to end grabirons being two on right side of end, is manifestly wrong. It is proposed to revise this to read same as the second paragraph in this respect and as shown on drawing A.2, and A.4, the revision being as follows:

First two lines and to period in third line, O. K. "They should also be provided with two horizontal grabirons or handholds, about 24 inches long on each side of end of car, not less than 18 inches," etc., etc., balance of paragraph O. K.

While this is the language that has prevailed for years in the second paragraph and is generally understood to mean, located "one" on each side of end, the word *one* is not used although it would make it clearer.

Reproduce drawing 1905. Mark A4.)

(In order to authorize and use the note under box and stock car views, A.1, A.2, A.3 and A.4, of sheet 19, a new paragraph is proposed, to follow the fourth paragraph on handholds, as follows):

"All other classes of house cars, such as refrigerators, furniture cars, etc., if constructed with projecting end sills, are to have ladders, sill steps and handholds as described for box and stock cars, and as shown in Fig. A.1 or A.2. If not constructed with projecting end sills they are to have ladders, sill steps and handholds as described for box and stock cars and as shown in Fig. A.3 or A.4." (Reproduce note.)

Fifth paragraph, O. K. (Reproduce drawing as in *1904*, omitting step on right side, omitting coupler. Show deadwood and uncoupling rod as left hand grabiron. Make title as in 1904.)

Sixth paragraph. (It is believed that paragraph six should be revised by leaving out the words "high side" in the first line. Paragraph five refers to "All gondolas with drop ends" and if paragraph six could be made to read "All fixed end gondolas," more inclusive language would be used and the situation made clearer. It is thought best to suggest authorization, as an alternate, the use of a

suitable number of horizontal handholds on the sides of gondolas, the argument being that it presents the same arrangement as on box and similar cars.

The original paragraph authorizes the side, vertical handholds which are not shown on the 1905 sheet, although so shown in former years to 1896, and it is believed that this should be restored. The Committee report on the recommended change of text also cuts out the use of brake step bracket as a handhold. This is a change of practice heretofore authorized for many years and should be retained.

Attention is called to the language of the last five lines of paragraph six, as being recommendatory rather than mandatory as to necessity for the end vertical handholds. If the alternate plan of using the horizontal handholds is contemplated, the end vertical handholds may be deemed unnecessary, and they have been omitted in the suggested revised drawing. This is in accordance with the 1906 sheet which shows the horizontal handholds and is consistent with the text as to mandatory requirements. It is therefore proposed to have the sixth paragraph read as follows: "All fixed end gondolas should be equipped with a vertical grabiron or handhold over steps on the sides of the car, about 24 inches long, the lower end to be placed about 6 inches above the floor of the car; or with a suitable number of horizontal grabirons or handholds about 24 inches long, over each step; and two horizontal grabirons or handholds on each end of car, about 24 inches long, 4 inches from the outside of car and not less than 18 nor over 30 inches above center line of draw bar; exception to be made where the car is provided with a brake step, in which case the bracket of the brake step can be used as a grabiron on that side of end of car, as shown on Fig. A.6, Sheet M. C. B. 19. It is also recommended that etc., etc., and last four lines O. K. (Reproduce drawing A.6 is in *1904*, omitting coupler and righthand side handhold Add alternate low side car, omitting brake step, showing two end handholds. On high side car omit platform on side view, show brake step. Also show alternate high side car, showing same as B end on 1905 sheet, but omitting the top handholds and the handholds and step on right side. Show brake step. Title as in 1904.

Seventh paragraph, O. K. (Reproduce drawing as in 1905, but omit steps on right side of end views. Notes O. K. Change title to read TANK CARS, A.7.)

Paragraph eight. (The section on Steps requires two steps on all cars but the present language of the eighth paragraph implies that some flat cars have none. It is thought wise to recommend revision of this paragraph, eliminating the words "And if not

dolas and other cars will also be applicable to flat cars. The revision recommended is as follows):

"All flat cars to be provided with horizontal grabirons or handholds, about 24 inches long, over steps near end of car where coupler unlocking rod is located, and two end grabirons or handholds, about 18 inches long," etc., etc., lines 5, 6, 7, 8 are O. K.

(Reproduce drawing as in 1905, except last end view which should show uncoupling rod and deadwood, one step only on left side; two handholds under end sill. Notes O. K. Make title FLAT CARS. A.8.)

(It is proposed to introduce a new paragraph following the eighth, which shall cover the general question of handholds on regular and special equipment, as heretofore referred to, reading as follows):

"Cars of other types of construction, not covered specifically in foregoing paragraphs of this section and not shown by the drawings on M. C. B. Plate 19, Standards for the Protection of Train Men, may be deemed of special construction, but shall have the complement of grabirons or handholds and steps or ladders as is required for cars of the nearest approximate type, and such handholds shall be considered as required by the rules of interchange.

Paragraph nine, O. K.

Paragraph ten. (This paragraph is not consistent with the foregoing paragraphs in reference to specified clearance. The paragraph on Ladders specifies a clearance of 2½ inches. Paragraph five, of the section on handholds for drop end gondolas specifies a 3-inch clearance for the handholds on under side of end sills. Paragraph seven, on tank cars and paragraph eight, on flat cars specify these under end sill handholds "same as for drop end gondolas," which would carry the idea of a 3-inch clearance. It is proposed therefore, to change the paragraph so as to define the clearances in accordance with foregoing specifications, as follows):

"Handholds on face of end sills should have at least 2 inches clearance behind them, and all other handholds should have at least 2½ inches clearances behind them except grabirons or handholds located on under side of end sills, which should have a space not less than 3 inches between them and the end sill."

Paragraph eleven. (This paragraph is not consistent with foregoing paragraphs relative to end handholds on gondola, flat and tank cars where grabirons or handholds 18 inches long are permitted although a greater length may be possible. It is proposed, therefore, to revise this paragraph and while doing so it is thought wise to include and validate the quite general custom of using uncoupling rod as an end sill grabiron when it has the proper clearance behind it as required by the preceding paragraph. Revised paragraph eleven is proposed as follows):

"All handholds should be made of iron not less than ⅝-inch diameter; handholds on sides and ends of cars should be about 24 inches long in the clear, except end sill handholds which may be from 18 to 24 inches long; provided also that the coupler unlocking rod, if properly located and having 2 inches clearance between it and the car will be a suitable end sill grabiron or handhold."

Paragraph twelve. Add Proc. 1905, 1906.

MR. SELEY: I might say in reference to this report, I had a meeting with four of the Interstate Commerce Commissioners' inspectors in my office and went over every detail of the matter, and I find that they are in entire accord and very much pleased that this revision is under way. The only debatable question with them was, they do not like the vertical hand holds on the gondolas. It was pointed out to them that we could not do away with these vertical hand holds with the present equipment which we have, and I pointed out to them that this clause gives the alternative of horizontal hand holds which they deem desirable.

PRESIDENT BENTLEY: This is a matter of very great importance. The drawings and the text will be introduced into the minutes of the meeting and will be available for those who wish to make use of them; car men particularly will be interested.

At our next meeting we will have Mr. E. W. Farnham, who has consented to give us a talk on "Equipping Steam Railway Terminals and Suburban Lines with the Electric Third Rail."

I hope each member of the Club will constitute himself a committee of one to try to induce desirable members to join the Club.

If there is no further business, a motion to adjourn will be in order.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

Library, 390 Old Colony Bldg.

Published monthly, except June, July and August, by the Western Railway Club, 390 Old Colony Bld'g
Chicago, Illinois

Club meets third Tuesday in each month, except June, July and August

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Vol. 19—No. 2 Chicago, October 16, 1906 $2.00 Per Year 25c a Copy

The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, October 16th, President H. T. Bentley in the chair. The meeting was called to order at 8 o'clock.

Among those present the following registered:

Allison, W. L.
Barns, C. R.
Barnum, M. K.
Beland, Geo.
Bentley, H. T.
Bigelow, O.
Boedenfeld, T.
Bott, A. G.
Broman, J. G.
Brown, Tom
Bryant, G. H.
Callahan, J. P.
Carlton, L. M.
Carney, J. A.
Chisholm, J. E.
Cooper, Wm.
Crocker, Lincoln
Crownover, G. M.
Cunningham, A. J.
Darby, I. W.
DeGroot, E. H. Jr.
Devoy, J.F.
Dewey, L. R.
Dowd, Willard
Eck, W. J.
Fantom, Wm. F.
Fenn, F. D.
Fogg, J. W.
Frumveller, F. C.
Forsyth, Wm.
Furry, F. W.
Grace, G. H.
Haig, M. H.
Hall, W. B.
Haynen, W. J.
Haynes, J. R.
Henning, Richard
Higgins, C. C.
Hopkins, G. H.
Jenks, C. D.
Jett, Emery E.
Kellogg, W. L.
Kelly, J. W.
King, C. H.
Krau, Chas.
Kucher, T. N.
Laying, J. F.
Lyman, Jas.
Lewis, O. H.
Little, J. C.
McAlpine, A. R.
McArdle, Edward
McCarty, E. J.
McIntosh, R. L.
McLelland, H. B.
Macfarlane, W.
Markle, J. R.
Martin, P. A.
Maus, N. R.
Marsh, E. P.
Mills, G. F.
Moody, W. O.
Moore, P. W.
Morris, A. D.
Neff, J. P.
Naylor, Norman C.
Osmer, J. E.
Park, H. S.
Park, S. T.
Phillips, L. R.
Pratt, E. W.
Richardson, G. A.
Royal, Geo.
Schlegell, F. von
Storrs, C. P.
Stott, A. J.
Street, C. F.
Sullivan, C. L.
Sullivan, E. B.
Taft, R. C.
Talbott, Chas.
Talmage, J. G.
Tawse, W. G.
Taylor, J. W.
Taylor, Thos. I.
Thomas, Chas. W.
Thompson, J. R.
Thompson, E. B.
Townsley, C. A.
Vissering, Harry
Wickersham, R. S.
Williams, W. E.
Wright, Wm.
Younglove, J. C.

PRESIDENT BENTLEY: The first order of business is the approval of the minutes of the last meeting. These have been printed and distributed, and if there are no corrections, will stand as printed.

The next order of business is the report of the Secretary.

THE SECRETARY: Mr. President, I have the membership report as usual.

Membership, September, 1906		1,292
Resigned	7	
Dead	3	
Dropped—mail returned	1	11
		1,281
New members		16
		1,297

RESIGNED.

R. Maxwell, C. B. & Q. Ry., Burlington, Ia.
D. M. Price, C. M. & St. P. Ry., Sioux City, Ia.
Ray N. Coats, Louisville, Ky.
C. W. Cross, L. S. & M. S. Ry., Elkhart, Ind.
Theron Higby, Milwaukee, Wis.
D. Hawksworth, C. B. & Q. Ry., Plattsmouth, Neb.
Geo. C. Purdy, Greenlee Bros. & Co., Chicago, Ill.

DEAD.

Paul Dickinson, W. A. McGuire,
W. T. Sprague.

DROPPED—MAIL RETURNED.

F. W. Herbert.

NEW MEMBERS.

Walter Chadwick, Special App., C. B. & Q. Ry., Aurora, Ill.
Edward C. Schmidt, Prof. of Eng., U. of I., Urbana, Ill.
J. H. Lyonmark, M. E., C. & A. Ry., Bloomington, Ill.
Wm. L. Bliss, Prest., Bliss Car Lighting Co., Milwaukee, Wis.
F. Urban, Supt., Bliss Car Lighting Co., Milwaukee, Wis.
N. B. Pennock, Auditor, Hicks Loco. & Car Works, Chicago, Ill.
J. H. Tinker, D. M. M., C. & E. I. R. R., Brazil, Ind.
W. L. Crossman, Beckwith-Chandler Varnish Co., Buffalo, N. Y.
Frederick Seaberg, A. M. E., Nat'l. Dump Car Ca., Chicago, Ill.
Sven E. Holmes, Draftsman, Nat'l. Dump Car Co., Chicago, Ill.
Theo. F. H. Zealand, Draftsman M. P. Dept., I. C. R. R., Chicago, Ill.
P. W. Moore, Ry. Specialty & Supply Co., Chicago, Ill.
W. A. Day, Erie City Iron Works, Chicago, Ill.
Thos. I. Taylor, Sprague Elec. Co., Chicago, Ill.
F. H. Rutherford, C. & E. I. R. R., Chicago, Ill.
R. E. Slate, R. H. F., C. R. I. & P. Ry., Blue Island, Ill.

THE SECRETARY: That is all the business I have.

PRESIDENT BENTLEY: We have with us to-night Mr. E. W. Farnham, of the Farnham Company, Chicago, who has a subject for discussion entitled "Electrical Power versus Steam Power in the operation of Railroads, especially as applied to heavy traffic

lines, passenger and freight, suburban and interurban lines, and large terminals." This is a very interesting subject to all of us, and so as to facilitate the business as much as possible, I would suggest that any questions you may have to ask the Lecturer be made a note of, so that at the completion of the talk the questions can be answered by Mr. Farnham.

I have great pleasure in introducing Mr. Farnham.

Mr. E. W. Farnham: Mr. Chairman and Gentlemen: The subject of my remarks and illustrations to-night will be Electrical Power versus Steam Power in the operation of Railroads, especially as applied to heavy traffic lines, passenger and freight, suburban and interurban lines, and large terminals.

Steam Railroads are the main arteries of commerce of the world. Electric urban and interurban railroads represent the smaller veins of circulation that give life and activity to local communities. Railroad men are among the most progressive of the age, always alert and taking advantage of every improvement in equipment and betterment of roadway that tend toward safety and comfort of their patrons. Development of the means of operating interur-

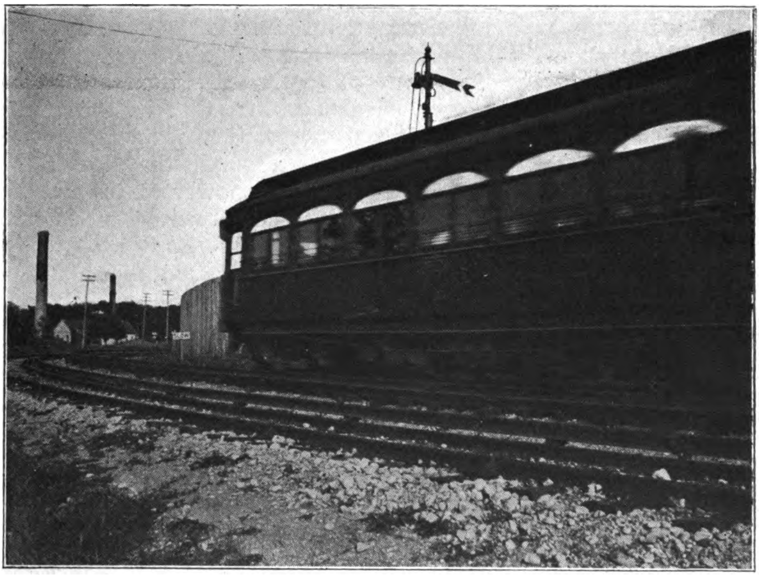

FIG. 1

ban roads by electrical power has demonstrated a possibility for a great advancement and improvement in steam trunk line operations. While, however, but little has been done by the steam railroads

looking toward the adoption of the most modern and economical power—electricity—yet it is to the credit of these progressive railroad men that they have carefully watched the progress made by their young competitors.

Much has been said and written upon the subject of electrical power versus the individual steam unit locomotive, but until quite recently nothing but theory was available. At this time, however, the adaptability of electricity as a motive power in the handling of heavy trains has been thoroughly worked out and demonstrated, as regards the lectromotive ability.

The methods of distribution of electric power to moving trains upon long or trunk lines will be referred to later.

What is the approximate relative value of the individual steam unit locomotive based upon its capacity as applied tractively, and the lectromotive under similar favorable conditions. Let us analyze the two systems and see what we have to deal with.

One of our western trunk lines recently purchased a supply of locomotives. Statistics show that each of these veritable power plants has a weight upon the track rails of 368,000 lbs. (184 tons), within a space of less than 70 longitudinal feet. Each has a supply capacity of 8,000 gals. of water, approximately 64,000 lbs., and 32,000 lbs. of coal. This maximum supply weight added to the engine weight makes an aggregate of 464,000 lbs., or 232 tons. If we deduct the dead weight of the locomotive, that is, the weight carried upon the leader and trailer trucks of the locomotive proper and the weight of the tender and its load, a weight that does not in any way contribute to the tractive or pulling power of the locomotive, it will be shown that the actual tractive weight of each of these gigantic machines will aggregate possibly 140,000 lbs., or 70 tons, thus leaving a mass of dead weight, of locomotive alone, of approximately 324,000 lbs.

Official details of Wabash R. R. Locomotive No. 620 show:

	Lbs.
Weight in working order	180,700
Weight on drivers	96,700
Weight engine and tender in working order	310,700
Making a dead weight	214,000
With a tractive weight	48 tons

Assuming that each of the locomotives first mentioned has a generating capacity at the boiler of 500 H. P., at the nominal rate of 4 lbs. of coal per H. P. hour each would require the consumption of 20,000 lbs. of coal every ten hours. All of this as an individual unit of power to haul an average train, representing possibly a load of 750 tons—25 cars, 30 tons each, to which should be added the

weight of the cars, say 25 cars of 15 tons each, which with the train load, 750 tons, would make an aggregate of 1,125 train tons.

It should be understood that the above basis is an assumed average for the purpose of analysis and comparison, and while doubtless the locomotives referred to may show a greater generating capacity, the ratio will remain the same.

A locomotive generating 100% efficiency at the boiler loses, according to the best authorities, 82% thereof, as between generated efficiency and tractive effect, thus reducing tractive efficiency to approximately 18% of the generated efficiency. Assuming an initial generated energy of 500 H. P., 18% would give but 90 H. P. actually exerted as tractive power, to haul a train of possible 750 tons train load.

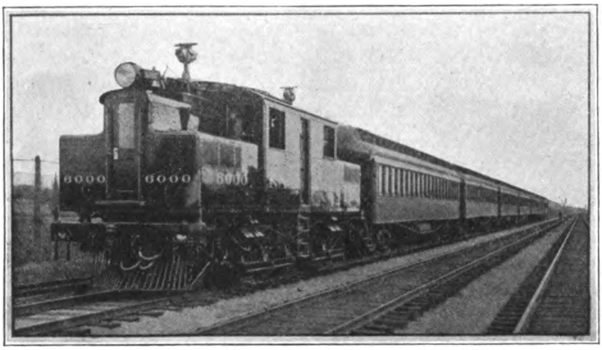

FIG. 2

I use the factor of 750 tons train load merely as a factor, to illustrate and make a comparison upon the basis of generated energy and applied energy. The N. Y. C. R. R., in making tests of efficiency of the lectromotive, and comparing results with steam performance, adopted a train unit of 400 to 600 tons as a basis.

How could a 500 H. P. central station steam unit be applied to advantage for the operation of electric locomotives?

A 500 H. P. steam unit in a stationary plant will generate approximately 93% electrically, or 465 H. P., because, first, the initial power is not called upon to carry or move its own load of machinery, boilers, fuel, water, etc., therefore has no load-carrying friction;

Second, because a greater percentage of constant energy can be generated in a confined boiler plant than in a moving one; and

Third, because greater efficiency is obtainable from a stationary plant by the use of compound condensing engines.

Having an electrical output of 465 H. P., if we allow 20% for loss or drop in transmission of the electric power, we will have avail-

able 372 electric H. P., over 72% of the generated electric power. In the use of electric motors the power applied at all points of the rotating armiture at one and the same time is upon the long side of the fulcrum, which gives the electric motor the maximum ratio of applied power, while with the reciprocal steam locomotive it is applied upon the short side of the fulcrum at the minimum ratio of applied power.

As the ratio of electric power applied and effective is granted to be 90% and over, it would require but 100 electric H. P. available to deliver 90 H. P. tractive effect, taken at the same ratio as the locomotive. If, however, we use 250 electric H. P. applied, 90% of which would be 225 effective, for one lectromotive, we will have a surplus of about 120 electrical H. P. available for other purposes. Suppose we increase the power unit to 5,000 H. P., using say 10 locomotives of 500 H. P. each, hauling a train and using all the power thereof, which of course is the only use it can be put to, hence the limit would be to haul 10 trains. Now, suppose we increase the electric power initial unit to 5,000 H. P. with an electrical efficiency of 93% or 4,650 electric H. P. If we allow 20% for loss of drop in transmission, we will then have available 3,720 H. P. 10 lectromotives, 250 H. P. each, would require 2,500 H. P.,—leaving a surplus of about 1,200 H. P. available for hauling additional trains.

Assuming the cost of generating the power and handling the trains in both cases to be the same, there is shown a saving of about 30% in favor of electrical power, if the surplus power is utilized in the movement of additional trains. Of course it should be understood that there are other features to be considered in the operation of lectromotives as against steam. In the latter less tractive weight is required to haul a given train weight on account of the better distribution of the tractive wheels upon the track rails and power application individually to each of the power axles.

If we were to illustrate the cost of operating a road say 300 miles long by individual steam units, locomotives, and compare the cost with that of a central station power unit and lectromotives, we would doubtless find the ratio approximately the same as shown upon the Long Island Railroad, which is given officially at .33, 3c per train mile by steam locomotives and 22, 1c per train mile by electrical power, or a saving in favor of the latter of 33, 6%.

This saving, however, in the cost of hauling trains, is not altogether from the saving in power, but from a decrease in salary account in train hands and other sources.

Assuming that the figures quoted are approximately correct, it would appear evident that electrical power, properly applied, is much more economical for use upon heavy traffic lines than is steam power by individual steam units, locomotives. These conditions of

railroading have been known for some time, but the advocates of steam lines, steam railroad operating men, have been averse to recommending the substitution of electrical power because of the fact that the means heretofore known for the transmission of the electrical power to moving trains upon heavy trunk lines were not adequate or practical. Any practical railroad operating man knows from experience with the common every day overhead obstructions that any overhead trolley wire system would be an extremely dan-

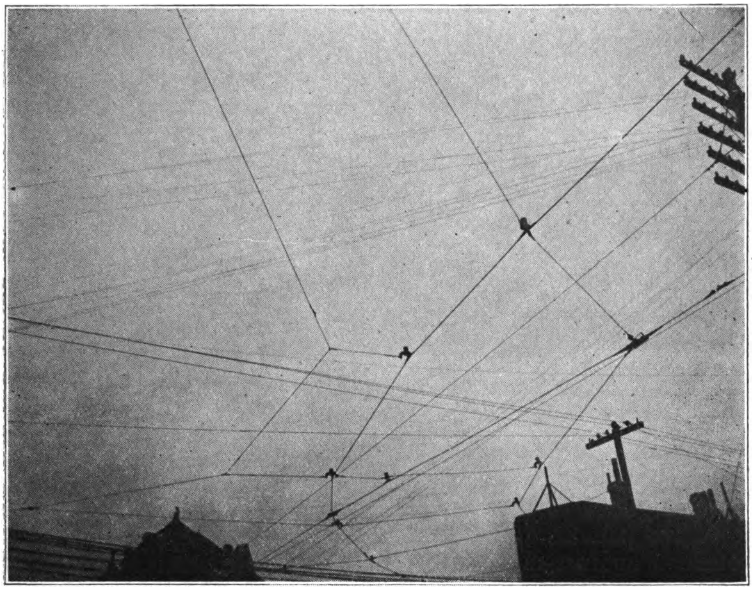

FIG. 3

gerous obstruction in the operation of heavy traffic, especially at terminals and elsewhere, where it becomes necessary for trainmen to occupy positions upon the top of freight cars. They know from history that such a system is inadequate, unreliable, always subject to weather interferences and frequent break-downs.

An illustration of the latter came to our notice quite recently in an article appearing in the Philadelphia Bulletin, Sept. 19th, 1906, from which I quote:

"The overhead wires on the new trolley road to the sea have been causing much trouble to the crews of the steam trains. This morning three steam trains had to stop between Camden and Westville on account of broken span wires. The conductors on the trolleys find it necessary to stand by the rope to prevent the poles from

jumping off the wire." This is what is known as the Atlantic City Electric line of the Pennsylvania Railroad.

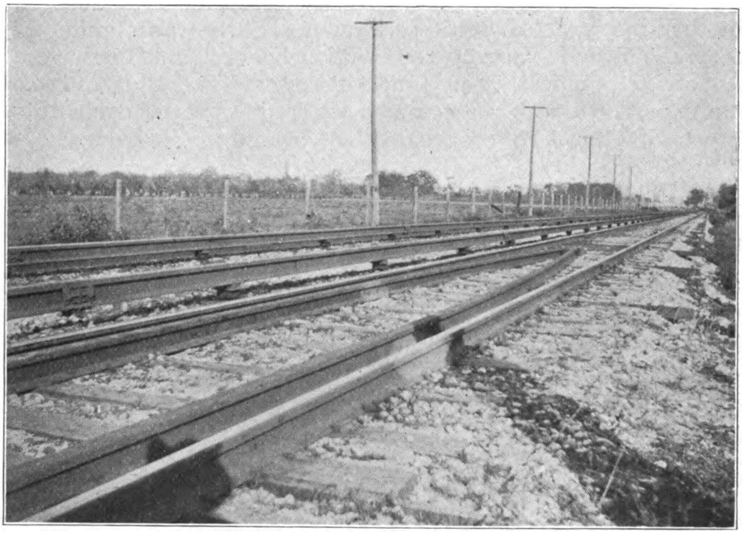

FIG. 4

Railroad men also know that what is classed as the *"open third rail"* is impracticable because of its dangerous and unprotected location contiguous to the service rails, endangering the lives of employes and patrons of the road, and unreliable because of its lack of protection against unfavorable weather conditions, its unprofitableness owing to its close proximity to the earth, thereby causing great dissipation and loss of electric power, and also by its being unadaptable for switching, yard service, and terminal application, where numerous switches and cross-overs are required and yard employes are from necessity obliged to walk over the tracks in the discharge of their duties, and would therefore be subjected to great danger of injury or death.

The view on the screen illustrates an open third rail, and the running rail by the side of it. Doubtless the most of you know all about it; it is not necessary to go into the details.

These conditions certainly warranted the disapproval of the substitution of electricity for steam power, and should continue to do so. Other conditions, however, exist at this time, which enable steam lines to be converted into electrically operated lines, and profitably so. None of these objectionable features exist with the "inverted protected third rail with under-running collector shoe." A

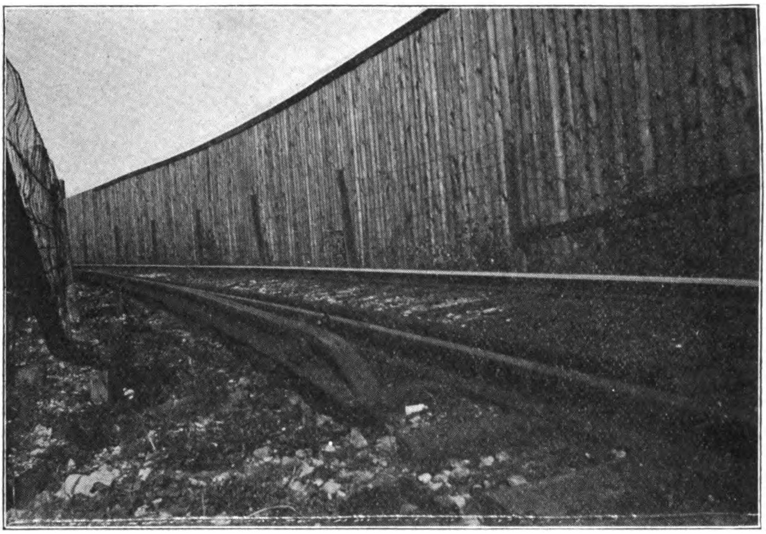

FIG. 5

system of the latter character has been devised, demonstrated and perfected from the practical railroad operating standpoint, and which meets any and all operating conditions,—affords protection against personal injury through accidental contact with the energized rail-protection against loss of power, and absolute protection against any and all weather interferences, such as snow, sleet, ice,

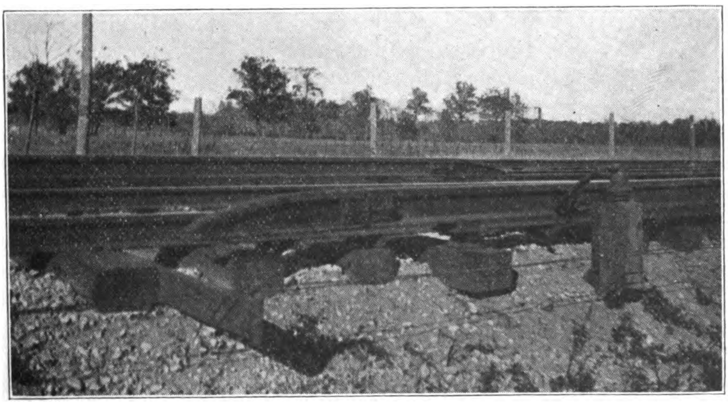

FIG. 6

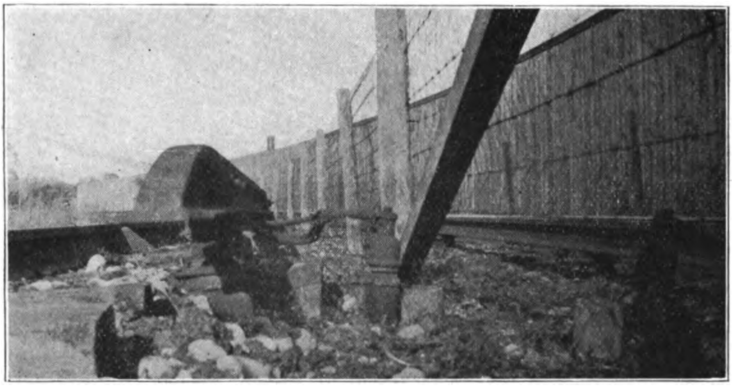

FIG. 7

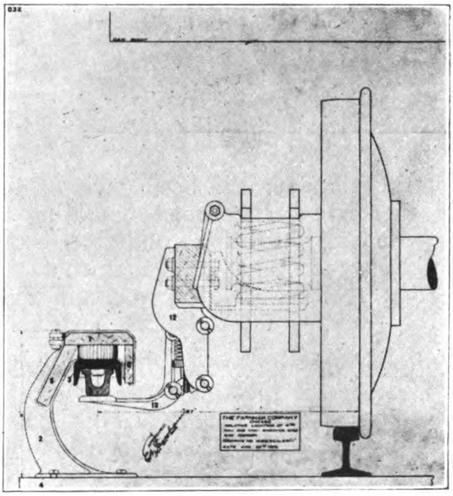

FIG. 8

rain, and high winds, thereby eliminating interruption to traffic movement and insuring

Maximum power delivery factor;
Maximum protective features;
Maximum durability;
Minimum power losses;
Minimum cost of maintenance;
Minimum interference to movement of traffic.

In other words, a perfected MEANS of *reaching* the *desired end.*

In this power question it should be borne in mind that in the

handling of a railroad by electrical power close attention is necessary at the *COAL PILE* from which emanates not only the power, but the *COST* basis.

A power plant properly constructed, carefully run and adjusted to the needs or requirements under changes in traffic conditions during different hours of the day and night, will show great economy over steam locomotive operations, the saving thereby constituting a very handsome dividend annually upon the entire cost of installing electrical power versus steam.

The cost of installing an adequate, complete and economical electrical power plant, with power distribution system, equipment (cars, motors, lectromotives, etc.), upon a new line, say 100 miles in length, would be considerably greater than for steam locomotives and equivalent train equipment. But the additional cost is a mere bagatelle when the saving in actual cost of operation is taken into consideration. And in addition to this saving, it should be borne in mind that with an electrically operated road terminal costs are reduced by about 60% and the investment in building and equipment reduced by 80 to 90%; eliminating round houses, washing boilers, cinder pits, coal yards, oil houses, cleaning flues and grates, coal chutes, firing up engines, water supply, turn table expenses, coal trestles, water tanks, and various other expensive accessories, interest upon the cost of which, together with the cost of operating and maintaining same, would aggregate no small sum.

All these conditions are known to investors who have faith in the bonds of a thoroughly equipped electric railroad, traversing a prosperous, supporting country, believing them to be the best and surest investment to be had, realizing that

THE *VALUE* OF A RAILROAD INVESTMENT DEPENDS WHOLLY UPON ITS EARNING POWER and the earning power depends upon two things:

FIRST: A substantial tributary business; and

SECOND: A low percentage of cost in handling such business and in the maintenance of the road.

Two very important factors in the successful operation of any railroad, and one of the reasons why electrically operated roads continue to be built and operated profitably in competition with steam roads:

The basis of cost of operating a railroad is the unit of cost per ton mile.

The cost per ton mile depends upon the amount of power efficiently and economically applied to a train.

It is impossible materially to increase the average power of our modern steam locomotives operating as an individual unit, and experience has taught operating officials that there is no economy in the long run in handling trains by double header locomotives, by in-

dividual unit control, which is necessary in all such operations, it being impossible to operate steam locomotives hauling a train under a multiple control. On the contrary, it is readily and economically possible to apply any desired power to a train by means of electric locomotives.

Therefore, with a solution of the problem of safe and economical distribution of the electric power, the conversion of steam operated railroads from the individual steam unit locomotives to electrically operated lectromotives and cars, would be a paying proposition upon a large percentage of our trunk lines. Some of the benefits to be derived therefrom will be

Increased capacity of terminals;
Reduction in operating expenses;
Reduction in terminal costs;
Reduction in cost of maintenance and equipment.

I will not undertake to discuss the merits or demerits of the locomotive, lectromotive, or other electrical machinery, but will refer to distribution by different methods.

THE TROLLEY.

There has been practically no improvement in the overhead trolley system since its first installation in 1887 and 1888, except in line of

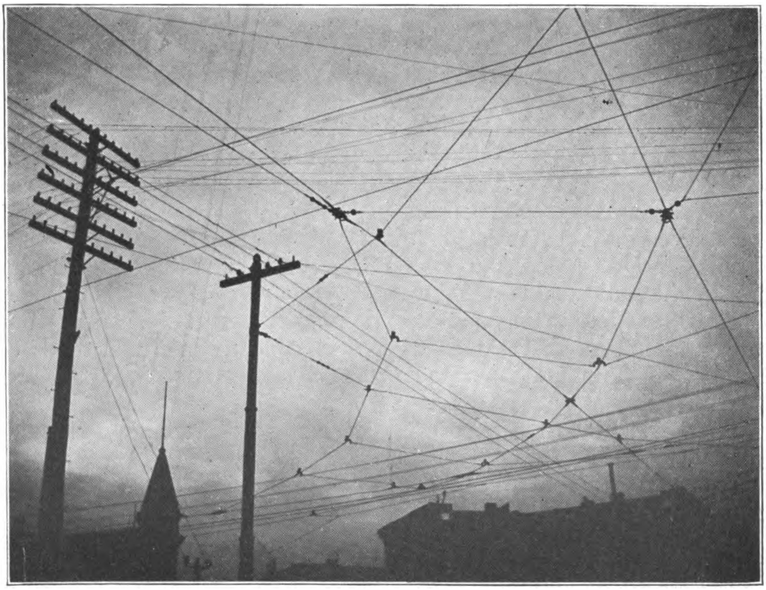

FIG. 9

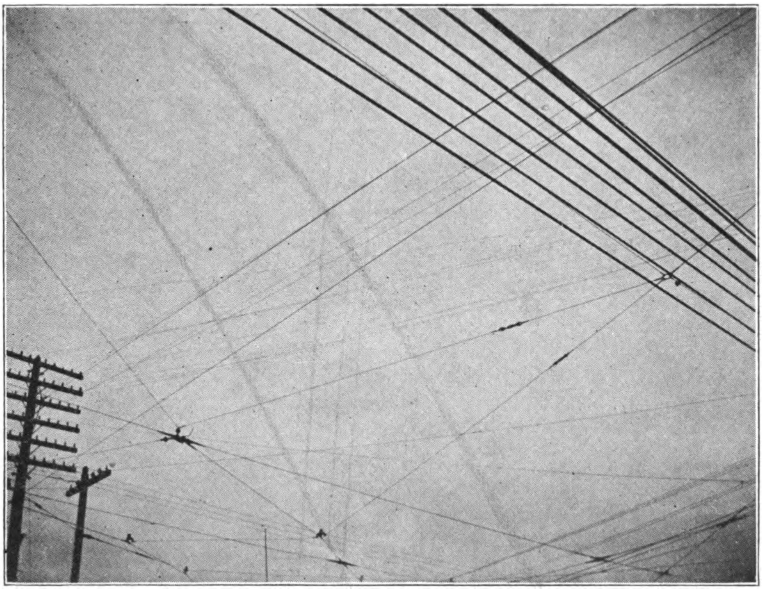

FIG. 10

mechanical devices used in its construction. The views shown upon the screen are without doubt a nasty tangle of power wires, suspension wires, guy wires, guard wires and strain wires, but shows a condition that might obtain were the overhead system used upon large freight terminals.

Is there any sane, practical railroad operating official who would for a moment favor or permit such a system?

It would not be safe to locate such a system over the tracks, owing to the necessity for employes on freight trains to pass over the top of cars, where they would be constantly in danger of contacting the live or suspension wires; and while it might be possible, in the open, to suspend the main trolley wires sufficiently high to clear an ordinary man while on top of cars, the small clearance under highways and other crossings would render it impracticable. It would be impracticable to suspend an overhead system with a suitable clearance and successfully operate upon it the ordinary pole trolley, even if the capacity of wire and trolley wheel were adequate for heavy traction work.

Picture what such a system would mean upon a modern freight terminal, or a freight and passenger terminal, like or approximating those shown on the screen.

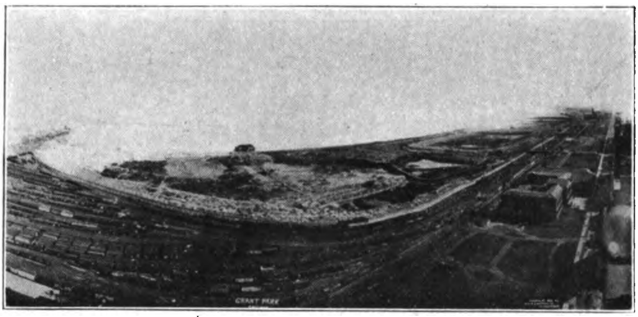

FIG. 11

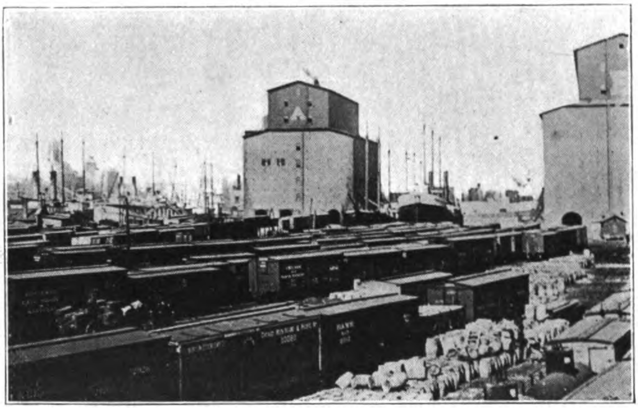

FIG. 12

THE OPEN THIRD RAIL.

The third rail (See Figs. 4 and 6), as most of you doubtless know, is located outside of the track or service rails, a distance varying from 20½ inches to 28 inches from gauge line to center of third rail, as may be necessary for car clearances, with the top or shoe contact surface at various heights above the top of the service rail, varying from 2½ inches to 5¾ inches.

This view, gentlemen, shows the shoe of an ordinary top contact third rail, the depending third rail shoe. These shoes weigh on an average, 14 pounds, as used on the elevated roads of Chicago, to 60½ pounds weight and spring pressure, on the Boston elevated road. A car at high speed, with that weight depending, must, when it approaches a take-up at a crossing, strike a tremendous blow, the evidence of which and result is illustrated in the next view showing the breaking down of the take-up on the far side or eastbound track. It also shows the westbound track, where the shoe lets go.

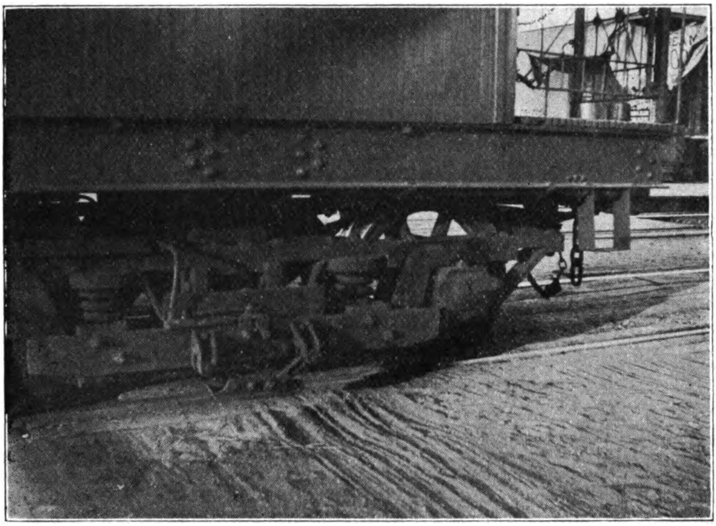

FIG. 15

The dangers from this exposed third rail are certainly obvious to all you gentlemen, in practical railroading, and while perhaps it is not necessary for me to go into full detail, I will, with your indulgence, enumerate a few of the most prominent objections.

Liability to injury or death to employes whose duties as section men, train men or otherwise, require them to work or pass along

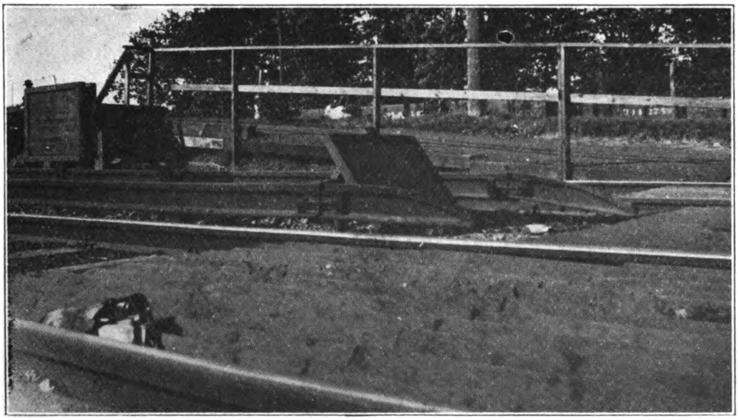

FIG. 16

the tracks, or to other persons trespassing thereupon. There are many cases recorded of maiming and death from coming in contact with this third rail. Probably the greatest danger to employes would be to the section men employed in replacing ties or tamping, and renewing track rails. The fact is, this latter could not be done without cutting the power off the third rail.

With this type of third rail it would be practically impossible to make repairs in case of derailment of train without a complete construction outfit, including rail drills, hydraulic press, soldering outfit, etc.

Inability to keep the exposed third rail, or a top contact third rail with a protecting hood, free from snow, sleet and ice, is indeed a very serious objection to its use, as it means great expense to the railroad company, serious delays to traffic, and enormous loss of revenue. It has been stated that with the hooded top contact rail heavy sleet storms fill the space above the rail solid with ice and tie up all traffic. I do not know but this feature makes a hooded third rail more undesirable than an open rail. It certainly is just as objectionable and dangerous in all other respects.

The view shown is taken from a tracing representing the hood as placed over a top contact third rail.

There are other serious objections to the open third rail as installed, one of which is the method of insulating.

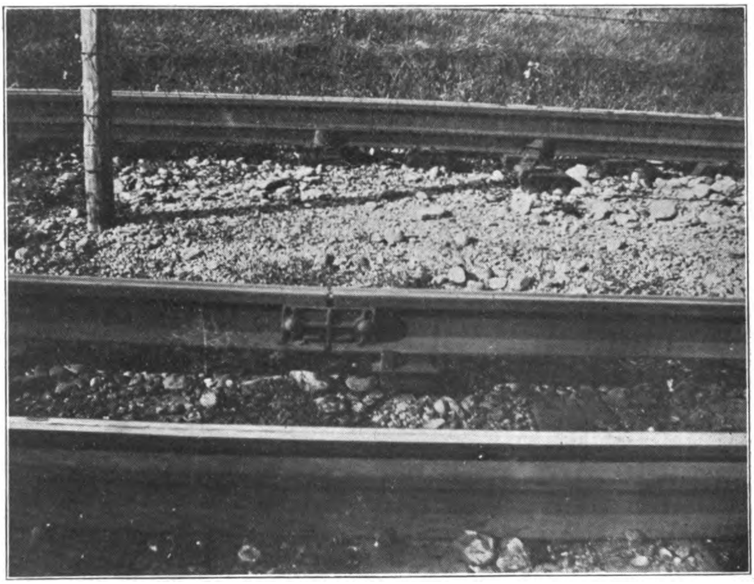

FIG. 18

It will be noted by the illustration that the only means of support of this third rail, which weighs anywhere from 60 to 100 pounds to the yard, is the insulating block between the cap and base. This block is usually of vitrified clay or reconstructed granite, which are, of course, of a crystaline formation. Any formations of this character are subject to disintegration and destruction by the adherent particles being separated by the pounding or jarring between the third rail on the top and the base portion underneath the insulator,

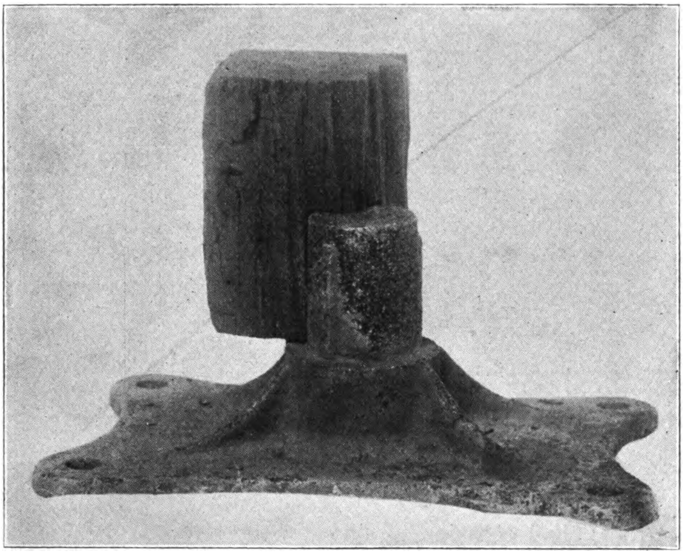

FIG. 19

caused by the vibration set in motion at the end of the extended ties by a passing train. Once an insulator is broken there is nothing to sustain the rail, and all the strain is thrown upon the next, and so on, until finally the rail must fall down and be beyond the contact of the floating shoe, possibly shortening the circuit and causing serious damage. The insulator shown is a broken insulator.

I wish to call your attention particularly to the protective hood for the otherwise exposed rail. You will note that the clamp forming the lower portion of the hood support is fastened to the energized third rail. Being of metal, it is surely a conductor of electricity. In this clamp is a riser of wood to which is bolted the transverse iron portion that sustains the board comprising the hood. Wood is a non-conductor; dry wood, yes; other wood,—well, sometimes.

In this connection I wish to give you a little *hearsay* evidence that even dry wood is not "sometimes" an insulator.

Upon this Atlantic City line, at the stations, there is a dividing fence paralleling the track. At such places the hood is used over the third rail. After the power was turned upon the third rail, the Superintendent of the Rail Bonding gang (this work was done un-

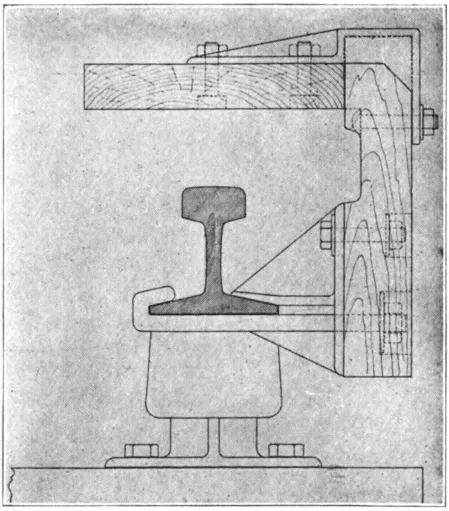

FIG. 20

der contract), had occasion to assist in the removal of a section of the dividing fence, to do which he must stand upon the hood covering. As this gentleman stated to me personally, he took hold of a bolt on the fence, and found himself upon the other side of the fence before he could think of any particular business calling him in that direction. It was not a sufficient shock to cause serious injury, but sufficient to jar him considerably. He immediately made an investigation, with a view of locating the direct source of supply, and while he did not succeed in that direction, he found that full 600 volts could be picked off the protection hood in places. I haven't the papers for this, only the word of the gentleman himself, and give it for what it is or may be worth.

With the objections already shown to exist as against the ordinary third rail used out in the open, it seems entirely unnecessary to take it into a switchyard or terminal, where conditions are more complicated and results would be far worse than outside straight line operation; and I will therefore pass on to the next stage.

We now have illustrated upon the screen the first inverted pro-

tected third rail with underrunning contact. This dates back to 1897, at which time I commenced experimenting upon a system of distribution of electric power which would embrace capacity, stability, durability and protection, the object at that time being to provide a means of meeting "Surface Line" competition, enabling steam roads to alternate electrically operated interurban trains with steam

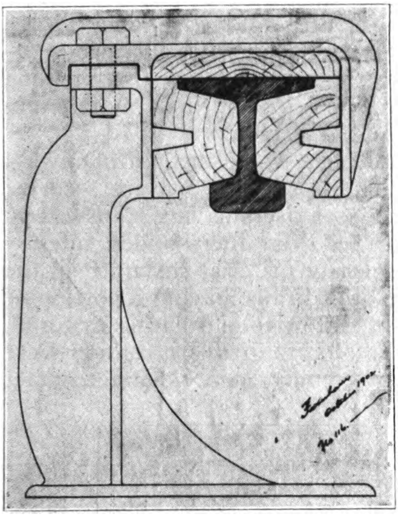

FIG. 21

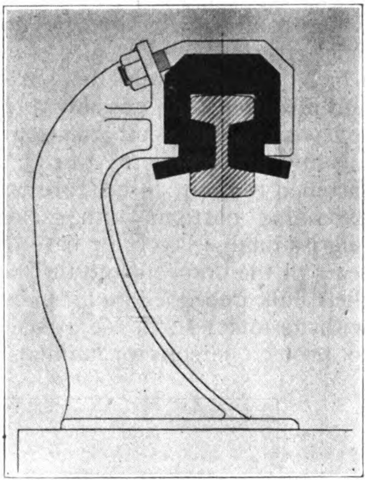

FIG. 22

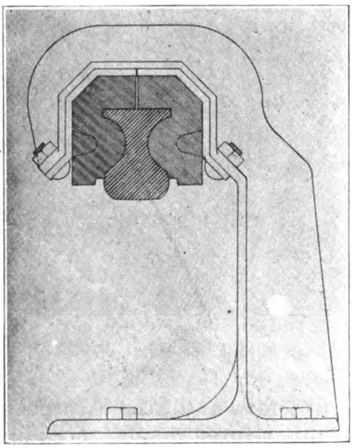

FIG. 23

operated through trains. Fram 1897 to 1901, in order to provide the greatest amount of protection to the steam trains, I experimented with and patented several sectional systems by the use of which all electric power was cut off the third rail except in the section occupied by the electric car, the operation of which was only applicable to the electrically operated car, and in no wise interfered with the steam locomotive or train. All of this experimenting was done while I was yet connected with the Chicago, Burlington & Quincy R. R., which company I served for upwards of eleven years in various official positions, and I wish to say that from 1897 to the present time I have probably given this particular and important field more study and attention than possibly any other one person.

I wish to call your attention particularly to the method of inverting and protecting the third rail. The brackets, which are securely fastened to the road-bed, are comprised of risers having transversely extending portions with sockets or seats on their under sides,—longitudinally, layers or bars of insulating material sustained in the seats of the brackets and the inverted third rails, having a portion of their bulk imbedded and supported in and by the insulating material, with its under-surface exposed. The objects of this invention were to protect persons or animals from coming in accidental contact

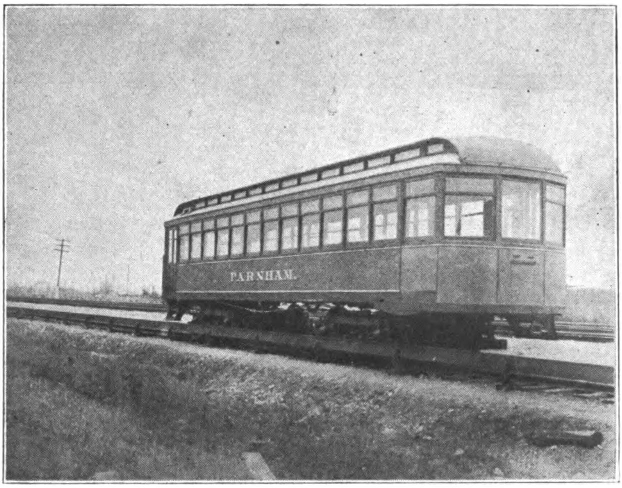

FIG. 24

with the energized third rail, and also to prevent the accumulation of sleet, snow, ice, or other foreign substances upon the rail, thereby eliminating interference with train movements. The form shown contemplated insulation within the bracket and an insulating or pro-

tecting covering upon the entire third rail between the brackets, being fastened thereto in proper manner.

We now exhibit the first car operated by a contact upon an inverted protected third rail. This car was first operated upon a track leased by me from the Burlington Road. All of our demonstrations, not only of the protected inverted rail, but also subse-

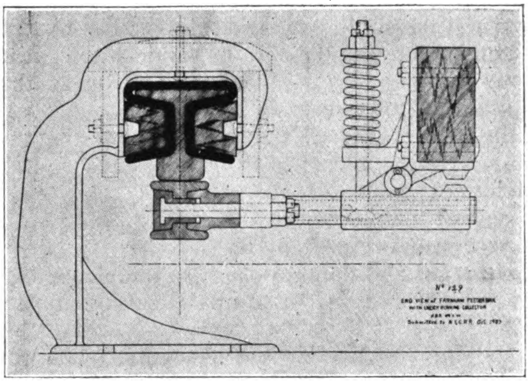

FIG. 25

quent inventions covering sectional systems and improvements thereupon, were made upon this track between Clyde and LaVergne, about nine miles west of Chicago.

We now call your attention to our form of inverted third rail designed for heavy traffic, using an 80 lb. section of soft steel. In our demonstrations of the third rail form of 1897, in which we carried the cover or protection upon the rail, we found it inadvisable to permit the protection to come in contact with the rail, for various and obvious reasons. In the first place, we found that in carrying a heavy load electrically the rail should have perfect air circulation for cooling effect, and second, that the covering when attached to the rail itself was liable to become water-soaked, which in cold weather would be expanded by freezing and the covering thereby broken off, and at all times liable to become a conductor, in which case the protection sought would not be present. We therefore decided upon the form shown, in which, as you will observe, the protecting cover is carried by the bracket itself and the rail insulated both from the bracket and covering or protection boards. This gives the necessary air circulation. In this particular case the boards are rather indistinct, as they are only shown by dotted lines.

In a recent thermometer test made by us Sept. 21st, 1906, at 11 o'clock A. M., we found the following conditions, which proved conclusively that our position as to circulation was correct. In this

test we found the atmospheric temperature in the shade to be 84, the temperature of the third rail under the cover out in the sunshine, 84; temperature in the sun, upon the cover board, 96. Temperature of track rail in the sun, 96. High west wind blowing at the time.

As early as 1901 I operated my car in contact with this third rail in all kinds of weather, heat and cold, rain, sleet and heavy snow, demonstrating its thorough, practical adaptability to railroad operating requirements, eliminating all the undesirable features, which warranted our making definite claims therefor at that time, and which were made as follows:

Some of the advantages of this system over the two other systems,—overhead trolley and open third rail,—are:

Saving in cost of operation;

Saving in cost of maintenance;

Saving in power, hence cost, by its

Positive insulation and non-exposure to the elements.

Protection against persons or animals coming in accidental contact.

Positively no interference by the elements. The covering absolutely protects the rail from all interference by rain, snow, sleet and high winds, all of which are annoying and expensive, causing delays to and loss of traffic under other methods of operating electric lines.

And for steam lines,

Cleanliness of operation, no smoke or cinders, saving in labor, fuel, repairs, maintenance, etc.

Ease with which full speed is attained, thereby lessening the running time and increasing earnings.

The ideal system for steam roads, capable of fully meeting all conditions and requirements of switching or yard service, crossovers, etc.

Blue prints of this form of rail were submitted to various steam railroads, including the New York Central, for consideration in connection with any contemplated electrification of such roads. Results obtained upon the New York Central have proven all our claims or at least it would so appear, if we are to rely upon the Street Railway Journal editorial bearing date of Sept. 2, 1905, some four years after our thorough demonstration of the system. I will quote the editorial:

"In view of the large amount of current required by the heavy train and the use of direct current, an overhead wire was not practicable. At the same time the commission that had the matter in charge looked askance at the ordinary third rail as somewhat dangerous, somewhat difficult to insulate, and involving a considerable amount of annual expense in the way of maintenance charges. It has been known for some time that the company has been experi-

menting on its tracks near Schenectady, with an inverted third rail and under contact, but the announcement this week that this system has been decided upon will, we think, create no little interest. The principal objection which has been raised to this form of construction in the past has been the difficulty of designing a satisfactory system of switches and crossing, but this seems to have been more theoretical than actual. In other respects, the system certainly possesses a number of advantages over the ordinary type of third rail, even with a protecting cover, and the adoption of the system by such a large corporation as the New York Central, and upon such an important scale as will be involved in this Company's 'electrical zone,' promises to settle for all time the relative advantages of the two systems of third rail contact."

The continued use of this system by that company, to the exclusion of all others, confirms the claims made by us as the result of our exhaustive tests.

With a view of providing a greater electric carrying capacity in a smaller space, using a steel rail for contacting and copper rein-

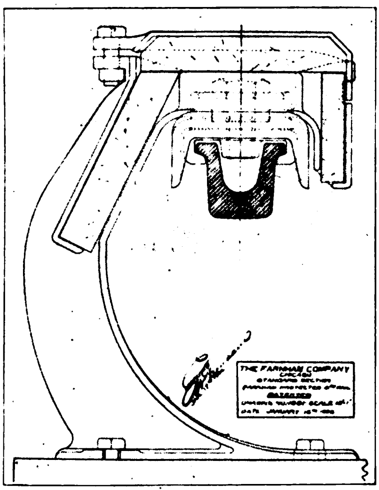

FIG. 26

forcement, and also to provide a more reliable means of supporting and carrying a heavy rail than by supporting it in and by its own insulation, for reasons which I have already explained regarding insulating material of a crystaline formation used in connection with the open third rail, the form now exhibited was designed, capable of carrying copper wire of any size from 300,000 to 1,000,000 C.M.

The brackets in this system are provided with deep pockets on

each side, front and rear, in which are held the protection boards shown in cross-section, which latter are of sufficient length to extend from bracket to bracket, as is also the cover board, all of which are firmly held in position by a single cover-lock bolted at the rear to each bracket. The special rail used in this system is of a U shape, provided with flanges at its two sides, by which it is suspended from the brackets in a manner that effectively insulates it from the brackets, as also its protecting cover-boards, and at the same time permits free longitudinal movement from expansion and contraction.

Sufficient allowance is made in the hanger to take up all vibration and jar between the iron hanger and steel rail that may be set up by the passing of trains upon the track rails. The method adopted for supporting the third rail is especially worthy of notice. The rail itself is carried by a malleable iron hanger which is engaged by the hanger bolt, the bolt passing through a bushing insulator in the top of the bracket, as also through rail insulator transferring the strain to the bracket through a compressional impinging of the bushing and insulator between the rail-hanger and washer underneath the head of the bolt. No amount of pounding or jarring can in any way interfere with or disarrange this method of construction. On the other hand, any method of supporting a rail in or by its own insulation, especially if of a crystaline nature, under a weight tension, is a dangerous proposition, as the vibration, jarring and pounding thrown upon the insulation directly between bracket and rail quickly causes disintegration of the insulating material, and total destruction follows, thus permitting the rail to fall, and make liable a very disastrous wreck to moving trains. Efforts to avoid these conditions resulted in the form now exhibited. It was also found necessary to produce an insulator of the highest dielectric and mechanical strength for use with a third rail where conditions are of such a dangerous nature. After long research, we succeeded in producing an insulator of a fibrous, vegetable compound, which tests prove to be of the highest strength, mechanically and dielectrically, thus perfecting a system of suspending the rail from which a loss of power is absolutely impossible. Under its application in conjunction with the rail and bracket, there is no tensional strain upon the insulator. The insulator bushing is fitted into the cup of the bracket. After the rail, with its hanger and insulator, has been erected complete, this cup is poured full of insulating compound of the same character as the insulator, covering the bolt and bushing, which eliminates all possibility of a foreign substance causing a ground or short between the head of the bolt and the bracket, and at the same time prevents the bolt from working loose.

The U shaped form of rail was designed to permit the carrying of a bare copper wire for reinforcing purpose, thereby increasing the carrying capacity of the rail to any desired requirement. The reinforcing wire is laid bare of insulation directly within the groove

of the rail, and a perfect contact made with the rail by the use of a compound plastic alloy bond at all rail joints, thus bonding the reinforcing wire and the rail joints at the same time. The rail itself is of very soft steel, made with a view to providing a conductor section of very high conductivity. This form was also submitted to the New York Central Road in December, 1904.

The view now shown (Fig. 8) represents the system as being installed upon the Philadelphia & Western Railroad, and which meets all requirements for terminal uses, cross-overs, switches and yard work.

In connection with the Philadelphia & Western installation we are using a special form of collector known as the Parallel. The collector itself as shown on the screen is marked No. 13.

It will be observed that the shoe proper and its vertical arm are one solid piece, connected to two links which oscillate from radial centers on the shoe carrier, so that any variation in the tension of the shoe or in the horizontal plane of the truck upon a curve, for instance, must at all times give a parallel or complete surface contact of the collector with the under surface of the rail. The links oscillate from a radial point, and any variation in track one way or the other, changes the angle of the collector so that at all times the shoe presses the full contact surface of the rail. It should be borne in mind that in turning a curve with this particular installation the third rail assumes the same relative position as the track rails, being carried upon the extreme end of the same ties. This is better illus-

FIG. 27

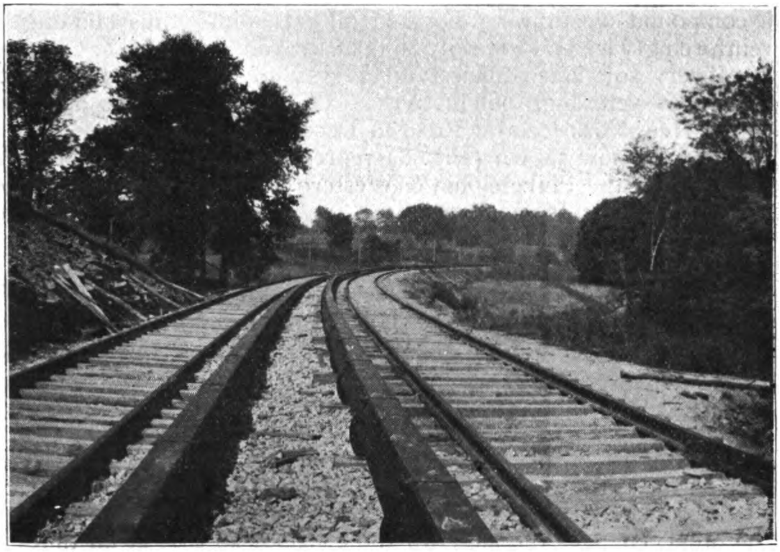

FIG. 28

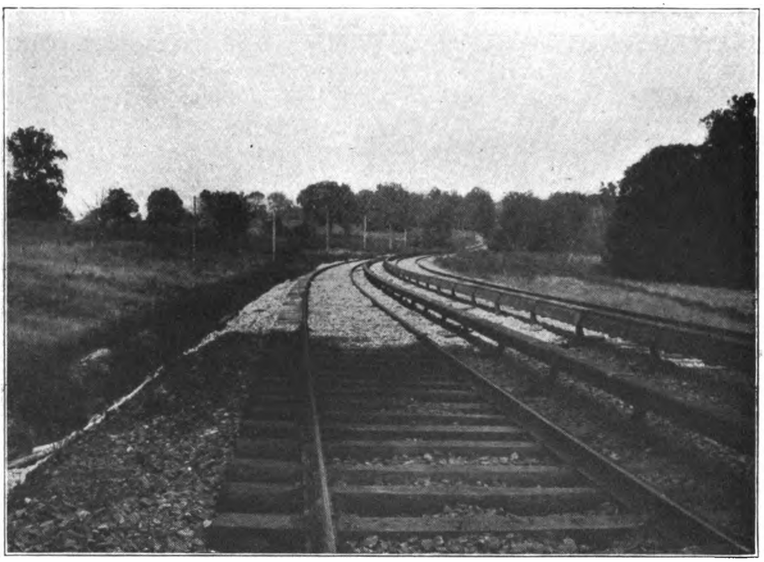

FIG. 29

trated by the view on the screen, which shows the rail under construction, the rail erected in the brackets but without the cover boards attached. The next view shows the same third rail with the

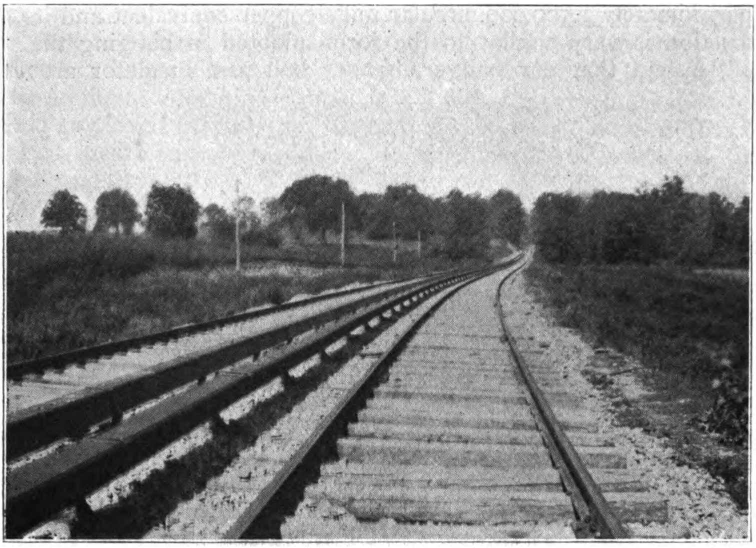

FIG. 30

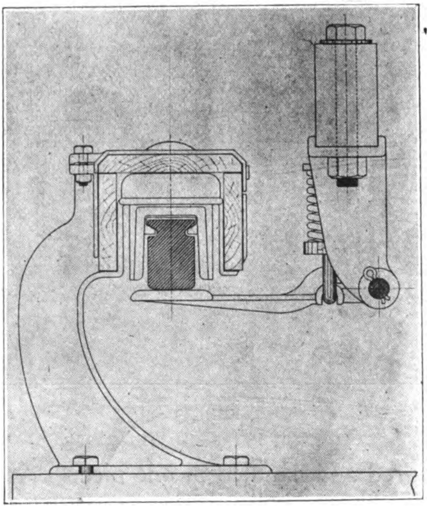

FIG. 31

cover board complete, and the additional views simply different sections of the line.

We have another form of steel rail, which is now shown upon the screen. (Fig. 31.) This is an 80 lb. section and has a capacity of approximately 1,500,000 circular mills copper equivalent and its construction is very similar to the form adopted in hanging the "U" rail, except that our hanger, hanger bolt and insulator are com-

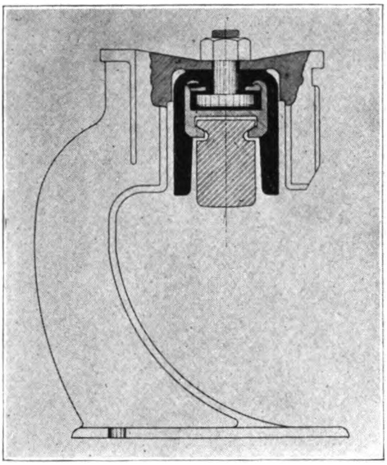

FIG. 32

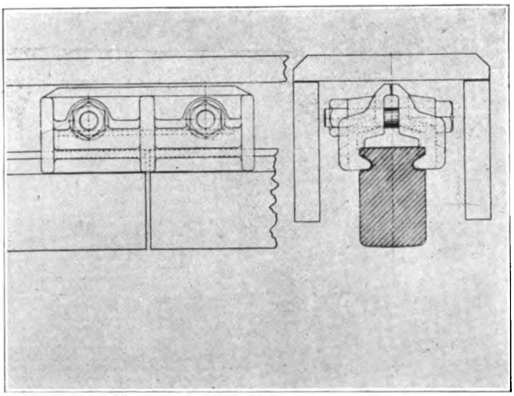

FIG. 33

bined, manufactured and handled in one piece. As will be observed of the bracket and hanger bolt. In the construction of this particular rail the parts are interchangeable. A rail can be removed and

by the view shown, any expansion or contraction of the rail, any vibration set up by moving trains, or any depression of the tie, by the loosening of the ballast, can be and is fully taken up between the rail and its metal hanger. In other words, we use metal to metal for all of the moving parts, as regards the rail and its suspension. This view as it appears is a sectional view through the center another put in place more readily than a track rail can be replaced.

The sectional view of our bracket is a better representation of the method employed in carrying the weight of an 80 lb. section of rail, metal to metal and yet with perfect insulation. The bolt of the hanger and insulator is passed upward through the bracket and within the bracket cup, which is inverted for the purpose of providing protection and greater supporting strength. The bolt has a tensile capacity of 5,500 pounds.

We use no plug or solder bonds, but a combined fish plate and bond. It will be seen that the fish plate attached to the top of the rail, located under and free from the case, is locked at all rail joints. Before being attached to the rail, the rail and the fish plate (of malleable iron), are amalgamated, after which the contracting points of the two are coated with plastic alloy, and the bond, simply a bare copper plate, also coated with plastic alloy, is placed within the fish plate, and as the fish plate is drawn into place by proper bolts passing above the top of the rail, it impinges the bond against the top surface of the rails, permitting of all ordinary expansion and contraction without a possibility of displacement of either the bond or fish plate. The fish plates are locked to the rails to prevent creeping. This represents the fish plate, side view, interlocked with the side of the flange of the rail.

Suppose for instance there should be a derailment of a train; as has already been explained, with an open third rail, plug or solder bonds, quite an outfit is necessary to enable the section men to replace the destroyed or damaged third rail. With our installation, the power being shut off of the third rail, as a matter of course, all that is necessary is to go to a point beyond the damaged portion of the third rail, in both directions, remove the cover boards, remove the fish plates, and the damaged material is ready to be scraped. New material, being interchangeable, can quickly be substituted, compound fish plates bolted on, cover boards attached, and the third rail is restored ready for use.

We now give you an end view of the 80 lb. section as it appears set up. The question may be raised as to the safety of this form of installation, to-wit, carrying the cover boards in a pocket provided in the brackets, the boards reaching from bracket to bracket.

It should be borne in mind that once the system is installed, any longitudinal strain upon one bracket is immediately transferred through the cover boards to the next bracket, and so on, making a continuous, self-bracing system reinforced by curves, and even

should a bracket, by the movement of a tie, be thrown out of place, sufficient for the side boards to drop out of the pocket, no harm would come to the moving train, as the side boards are fastened to

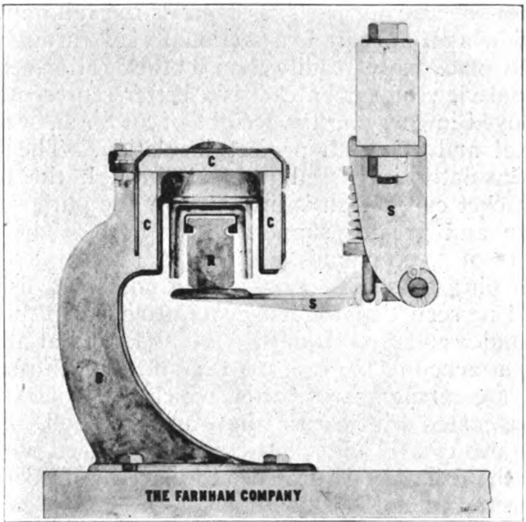

FIG. 34

the top board, which cannot drop. But this is a condition not at all likely to obtain.

In this view we show a single collector shoe held in position against the lower surface of the rail by two springs, but without the parallel motion.

We now exhibit upon the screen a drawing of a double track showing a cross-over. This seems to be the important feature in

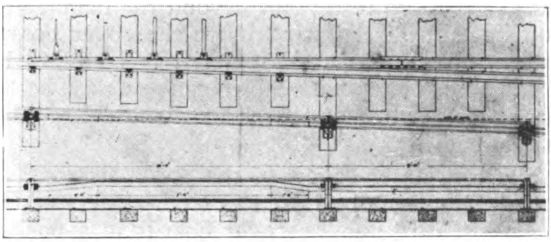

FIG. 35

the operation of a road, as to how trains may be handled at a terminal. This cross-over is drawn to a scale required in the setting for a No. 8 frog with 13 foot track centers. It will be observed

that the point of clearance of the third rail on the cross-over and between the cross-over and the opposing track is carried into the angle as far as possible to permit of clearance by all equipment upon

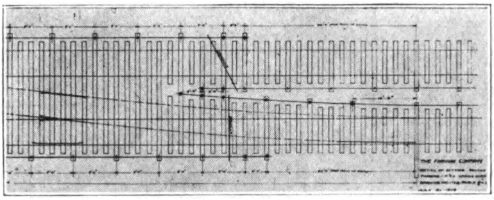

FIG. 36

the tangent track. At the opposite end of the cross-over the third rail is brought down in the opposite direction, or, in other words, following the cross-over to the limit of clearance. On this particular length of cross-over there is a distance of 49 feet between the nearest points of the third rail and 54 feet between the nearest point of contact of the collector shoe upon the same respective third rail. This view shows the third rail set up at the switch point. The dotted line shows the point of clearance of the collector shoe on car running upon the tangent track. As the car approaches the point of the switch on the tangent track, assuming the car to be moving in the direction of a trailing switch point, the point of the collector is outside of the third rail until it reaches the center of the switch point section of third rail. At this point it is half way under the rail. This particular section of third rail, reaching from the heel to the point of the switch, is bent or raised upwards, as shown in the illustration, thus permitting the collector shoe to pass underneath as it approaches the point of the switch, at which point the collector is immediately under the rail and is taken up by the third rail, the same as in all other cases of take up ends. In the movement of the car upon the switch or cross-over the shoe does not leave the third rail until it reaches the end at or near the tangent track, as has been explained.

Of course with a single car unit with say 28-foot track centers, it would be necessary to coast considerable of this distance, but with a three car train unit provided with collectors, the cars being of the approximate length of 51 feet each, the train would never lose power in going over a cross-over. It will be noted that at all points of cross-over the adjacent tracks are provided with a short section of third rail on the outside of the respective tracks at a cross-over. This condition of cross-overs and switches will largely obtain at all terminals by the use of the protected system, but there will be conditions of switching which an ordinary short lectromotive cannot handle satisfactorily if it must be in contact with the power at all

times during switching movements. There are other means at hand, however, which will enable the handling of freight and passenger equipment in any terminal more economically than by steam loco-

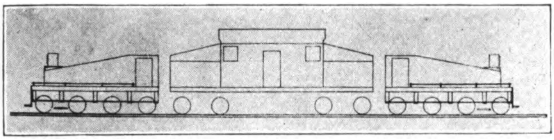

FIG. 37

motive switching. That is by providing each switch engine with a fore and aft car, or what might be termed a supply car. There are many advantages in an arrangement of this latter character. In the first place, flexibility in handling a train around a short curve. Second, the advantage of doing all the braking upon the fore and aft car trucks, as also all the power collecting, instead of upon the motor truck of the lectromotive. It will readily be seen that an electric locomotive switching under power, in the event of an emergency application of the brakes, the strain upon the motor car and trucks would be considerable; whereas, if the braking is done upon the fore and aft car, the strain would be entirely removed from the motor trucks. There would seem to be many advantages to be obtained by the use of a fore and aft switching car used permanently upon all switching lectromotives. These fore and aft cars should be so constructed as to provide safe foot boards for switchmen, with storage space for such necessary yard accessories as are from time to time required, and possibly at the same time afford shelter for employes during inclement weather.

As will be observed by the view shown upon the screen (See Fig. 8), the collector shoe extends a little beyond the axle boxes, but not as far as the body of the car. Yet at stations and station platforms where it has been the practice to plank flush with the top of the surface rail, the elevated third rail could not well be used, unless the platforms were raised to the line of the top of the third rail protecting case and extended to become a part of the protection, with the shoe running underneath the edge of the platform. In other words, all tracks would appear depressed. This of course would mean that at all crossings in a large passenger station, where it is necessary to transfer trucks, baggage, express, mail, etc., across the tracks, the third rail would be broken, and the platform depressed for such purposes, practically the same as at all grade street crossings, highway crossings and farm crossings; but it is not a serious objection to the use of the protected third rail. In this particular respect I wish to add that there is not a condition of railroad train operation that cannot be met by the protected underrunning third rail, and to

the entire satisfaction of any railroad adopting and using same. There will in all cases be special work, peculiar to certain yards or terminals, which must be figured out, but it is not a serious problem, especially as it appears to us from our past and recent experience. The New York Central is using our inverted protected third rail with underrunning contact, and we present for your information a view of two sections of this third rail as it appears near the north portal of the Third Avenue tunnel, New York City.

It should be and doubtless is apparent to most railroad men that

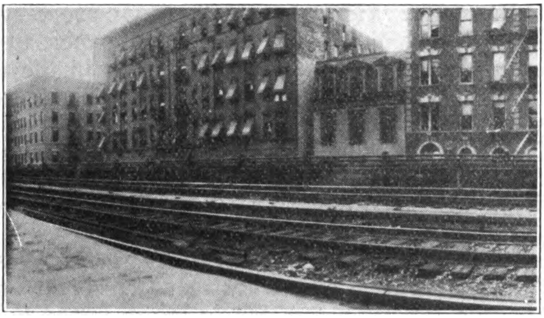

FIG. 38

the equipping or conversion of steam roads to electrically operated roads must be in the hands of a person or persons personally and thoroughly familiar from experience with all local track conditions, local operating conditions, and traffic requirements of an individual

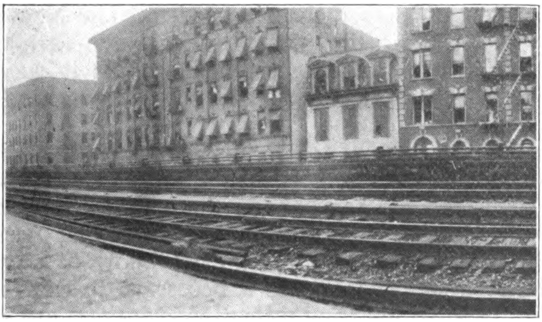

FIG. 39

road to obtain the best substantial results. Such person or persons should have had a practical operating experience thereupon, and thereby be capable of grasping the situation quickly, whether it be from the mechanical or electrical side. A purely electrical engineer

would rarely be equipped with a practical knowledge of railroad affairs to such an extent as to enable him to supply the needed information. It is quite generally believed that the steam railroads are quietly selecting men from their own rank and file who have a knowledge of local conditions and whom they believe to be capable of acquiring an efficient knowledge of the other one factor,—electricity; and are educating them to fill important positions when the time shall have arrived for active efforts in this direction, and to these men will be due the credit of electrifying steam roads.

Gentlemen, I thank you for your attention. (Applause.)

PRESIDENT BENTLEY: Gentlemen, I think we are very much indebted to Mr. Farnham for an interesting paper to-night. A large number of difficulties that I had foreseen in the use of the electromotors in freight terminals have been taken care of very satisfactorily by the speaker.

I notice that we have a number of gentlemen here who are interested in this sort of thing, among others I believe Mr. C. F. Street, of the Westinghouse Electric & Mfg. Co., and we would very much like to have him open the discussion.

MR. CLEMENT F. STREET, (Commercial Engineer, Westinghouse Electric & Manufacturing Company): Mr. President and Gentlemen: I have been greatly interested in what we have heard this evening and the illustrations which have been presented by the speaker of the evening, but cannot agree with him in everything he has said. It has, however, been repeatedly stated that it is a good thing we do not all think alike or there would be very little advancement in the world.

One of the statements with which I am afraid I shall have to disagree is that the under-running third rail conductor will meet all of the requirements of heavy electric service. The New York Central Railway is installing this system in its New York City terminal and there must be some requirement which it does not meet as at a number of places they are putting up an overhead conductor to help out.

The Atlantic City Line of the Pennsylvania Railroad is equipped with a third rail system but it is very noticeable that an overhead trolley has been installed for helping them over some hard places. I think it probable that other instances of a similar nature can be found, while on the other hand I do not know of any where an overhead trolley system has found it necessary to call on the third rail to help it out of trouble and do not believe there are any such.

This question of the transformation of steam railroads into electric railroads is one of tremendous proportions, and I cannot agree with the speaker in his statement to the effect that there is at the present time no heavy railroad service now being operated by steam locomotives which cannot be operated to better advantage by the use of electric equipment.

I am not prepared to say that such is not the case, but I do not believe that we know whether it is or not. This whole proposition is in its infancy. It has only begun and its growth must be gradual. The development of the electric street and interurban railways of this country to their present high degree of efficiency represents a rapid succession of engineering achievements the like of which the world has never before seen. The beginning was with street railways. Interurban railways followed closely and the success of these showed beyond a doubt that electricity was the only proper agent for handling elevated and suburban railway traffic. The elevated railways are electrically equipped and work is progressing on the heavy suburban lines. Within a very few years every heavy suburban system not only of this country but of every large city of the world will beyond a question be operated by electricity as it has been proved beyond the peradventure of a doubt that this agent is the only one which can fully meet all the demands of this service.

After some of our heavy suburban traffic has been successfully handled by electricity and extensions have been made to portions of main lines, we will know more about what it can do with through heavy service, but I do not believe that any one is, at the present time, in a position to say definitely that electricity can be employed to better advantage than steam for operating all trains on runs such as that from New York to Chicago, or Chicago to San Francisco. This is the sort of thing we must work up to gradually.

The speak er has said many things about the weak points and objections to the steam locomotive, the overhead trolley and the underrunning third rail, and would have us believe that his under-running third rail is the panacea for all the ills which appear in connection with them. In spite of his statements, however, the steam locomotive seems to be pounding along and making a pretty good record, will continue to do so for many years to come, and just a few new locomotives are being built.

The overhead trolley is giving excellent satisfaction and hundreds of miles of new line under this system are under construction.

The top contact third rail is meeting the requirements of elevated railway service and will continue to do so for many years, although its future field is limited.

In the discussion of the relative merits of the overhead trolley and the third rail is a much larger question than merely that of whether the type of conductor shall be an overhead trolley or a third rail, as the third rail conductor is necessarily a D. C. conductor while the overhead trolley may carry either alternating or direct current. Any discussion, therefore, of the relative merits of these two types of conductor must necessarily be a discussion of the relative merits of the A. C. and D. C. systems. You are all undoubtedly

familiar with the arguments which have been advanced by advocates of each of these two systems, and it, therefore, hardly seems necessary to go over the ground which has already been so thoroughly covered. I should, however, like to repeat a statement which I have made before, which is that it would be just as reasonable to undertake to operate all of our railroad trains with steam locomotives carrying 50 pounds pressure to the square inch as it would be to operate this traffic with an electric current of only 500 or 600 volts. With the D. C. system the voltage is limited to that which can be successfully employed for the operation of a motor, while with the A. C. system a trolley wire pressure can at the present time be obtained and successfully handled which is far beyond the demands of any service at present known.

The speaker made the statement that there had been no improvement in the overhead trolley. I shall have to differ with him on this point. A few years ago 500 volts in an overhead trolley was considered dangerous, and an increase from 500 to 600 considered quite an undertaking. Today a number of roads are in successful operation carrying 6,000 volts in overhead trolley, and the New York, New Haven & Hartford Company is installing a system in which 11,000 volts will be carried. I think you will all agree that an advance from 500 to 11,000 volts is a considerable improvement. The first overhead trolleys that were put up were very flimsy affairs and carried entirely on wooden poles. Today steel poles are employed for probably the majority of lines and overhead bridges with catenary construction for supporting the trolley wire are being used for heavy traffic.

The speaker mentioned the difficulty of collecting heavy currents from a trolley wheel. A trolley wheel is not used in connection with the collection of currents under the A. C. system and no difficulty whatever is experienced with the use of a sliding contact bow trolley. In fact this is one of the easiest problems to solve in connection with the introduction of the A. C. system.

One of the slides represented by the speaker showed a complicated switching yard, and he requested us to imagine this yard equipped with an overhead trolley. I should like to ask you to imagine this yard equipped with a third rail and switchmen attempting to step over it in making up trains.

As I said before, this entire question is one of development. I do not believe any railroad now operating steam locomotives will substitute electric equipment for the reason that it will cost less to operate. I do not believe they will make this move for the reason that it will cost less to maintain it, and I am firmly of the belief that when such a change is made, it will be made because electric equipment will do things which the steam equipment will not do. The entire question is one of meeting the demands of service. When the de-

mands of service exceed the capacity of the steam locomotive, electricity will be adopted for the reason that electricity will meet demands which the steam locomotive will not meet.

President Bentley: I have been very glad to hear from you, Mr. Street. One side of a tale is always good until the other side is told. That is why we like these meetings, and we like to have some discussion. There are other gentlemen in this room who are very much interested in this subject. I would like to hear from them. The hour is early and the subject is very interesting.

Mr. James Lyman (Gen. Elec. Co.): Mr. President: Mr. Farnham has shown some interesting designs of the third rail, and incidentally has spoken of some features that have brought the electric operation of trains to the front, namely: the simplifying of the train service, the increased capacity of railway terminals, and the economy obtained over roads having frequent train service.

The New York Central will be able to do away with a large part of their train yards, their round houses, and at the same time very much increase the capacity for handling their service. A couple of years ago the London & Northeastern Railroad adopted electric drive for some 70 miles of their railroad in the region of Newcastle, from Newcastle-on-Tyne down to the ocean. I was there just after the electric trains were put into service, and the managing director of the road told me that they had come to a point where a very large increase had got to be taken care of in some way. By the adoption of the electric drive the capacity of this great terminal and the 70 miles of road for handling passengers was practically doubled.

I think that the speaker has suggested more danger in connection with the operation of open third rails and the trolley than is really found in practice. We have here running out from Chicago to Aurora and Elgin about 60 or 70 miles of third rail high speed road. The limited cars make a maximum speed of 65 miles an hour, and the regular trains a schedule speed of about 35 miles an hour. They have been running for something like four years and I believe that the only instance of a man's being killed by coming in contact with the third rail was the case of a man who was very much intoxicated. The railroad has had gangs of Italian men ballasting the road ever since it was built, and I am quite sure that there has never been a serious accident to any of these men.

As Mr. Street has pointed out, the third rail is only one means of meeting the requirements. The trolley has been successful, and it is going to be successful for a long time for single car and light train service. The various types of open third rail are going to be successfully used for a long time. The New York Central has adopted a protected third rail with an under-side collector surface that bids fair to be satisfactory in the complicated connections of switches at the New York terminal.

President Bentley: We would like to hear from others on this subject. Mr. Osmer, can we call on you?

Mr. J. E. Osmer (Northwestern Elevated R. R.): Mr. President, I don't want to dispute anything said by Mr. Farnham, but I knew of a Chicago man who took great pleasure in sitting down on the third rail to eat his lunch.

The open third rail has been stated as giving very good service about the city. I don't know of any instance when any one has been dangerously injured through its use, and I believe it will be in use, especially on elevated roads, for a good many years at least; it is giving good service; and also on interurban roads. I have enjoyed the discussion very much, and I would like to hear others talk.

Mr. E. W. Pratt (C. & N. W. Ry.): I would like to ask a question. Will Mr. Farnham tell us how he would propose to do wrecking on three or four tracks on the N. Y. C. in case the power to move the wrecking car to the wreck and to do the wrecking is to be taken from the third rail.

Mr. Farnham: In any installation of the third rail upon a number of tracks it necessarily follows that the third rail must be reinforced, which is the case on the New York Central, carrying the power from the conduits through tap on switches, and through which medium in most cases power may be obtained while the third rail is out of circuit. This, however, is a condition, which in railroading must be met at the time. As has already been explained, in the case of a wreck, derailment of train, destruction of third rail, etc., the first condition to be met is to disconnect the third rail or rails both sides of the wreck by removing connections at rail joints. This would enable the power to be supplied upon the remaining portion of the third rail and the wrecking car run up to the wreck, or to the end of the rail near the wreck from which point, with the necessary accessories of a wrecking outfit, power could be obtained from the third rail or otherwise. One would not suppose that upon a road like the New York Central they would carry all the power upon the third rails, hence it should be an easy matter to provide ways and means for obtaining power while removing a wreck. I understand the N. Y. C. are arranging along its line, especially in the tunnel, for the necessary switches and connections for just such purposes.

A Member: I would like to ask if the electromotive is always equipped with collector on both sides, so that the train can run on either east or west bound tracks?

Mr. Farnham: Ordinarily an electromotive would be equipped with four shoes, two on either side, and as far apart as possible.

President Bentley: We are all coming to it, gentlemen, we might just as well talk about it sooner as later. Now get busy. You ought not to require very much inviting, it is too interesting a sub-

ject to have to call you by name. If there are no other questions to be asked—I don't want to cut short discussion, because I feel, like a good many more of you, that it is a coming subject with us, but if there is further discussion we will have to call on Mr. Farnham to close it.

MR. FARNHAM: Mr. Chairman: It is very true, as stated by Mr. Street, that trolleys have been doing service and are doing service of their kind, and trolleys will continue to do certain service. There is no other known means of operating electric cars under certain conditions. We don't advocate the third rail for use in the middle of the street, notwithstanding the fact however, that the Brooklyn Rapid Transit did put a top contact third rail with a hood cover, under the elevated structure in Brooklyn on Atlantic Avenue out to the city limits, but teams were not allowed to drive in or across except at street intersections. You could not do that in Chicago. In Chicago the street car companies do not own the streets. In such cases you would have to use the old standby—the trolley. It will deliver a certain amount of power, we all have to admit that; but with a steam railroad, with its own terminal, not operating in the streets but upon its own private right of way, my third rail can be adopted to operate every inch of its terminals. The New York Central did resort to a trolley in some cases, but why did they do it? Because they were operating with the lectromotive only in contact with the third rail and could not span openings without losing power. It is not necessary to put up a trolley for that purpose. We have a detachable collector which may be applied to any car previously provided with permanent fixtures or collector carrier. To illustrate, take the New York Central lines, operating by steam from Chicago to Albany, and from there to New York by electric third rail. The cars are fitted with permanent collector carrier attachment, wired for electric lighting and power transmission. These fittings are not in the way while the car is being operated upon a steam operated line, no more so than they would be in connection with the third rail section. Before the train goes from the steam line section to the third rail section, the detachable shoe is put upon the rear car of the train, or more if desired, and removed again when the car or cars leave the third rail section, and kept for subsequent use upon other cars. It takes but a moment to make the change and is just as permanent and reliable as a permanently equipped car or lectromotive. When this is done the train will span any opening, any crossing or switch end, because the train is wired from the rear end of the train to the lectromotive, and power is being taken by any or all of the collectors in contact with the third rail.

It is also true, as Mr. Street says, they are experimenting with high voltage, any where up to 11,000 volts; they are trying it upon several lines, but it is very much more in its infancy than has been admitted. But I will state that in the operation of heavy lines, it is

going to be by a higher pressure than 600 volts, probably up to 2,000 volts D. C. pressure for such lines; but it will be D. C. and not A. C. as I look upon it. I think I have covered all the important points raised, Mr. Chairman.

MR. B. F. SIPP: Mr. President, I have listened to this address of Mr. Farnham with a good deal of pleasure to-night, and I do not believe there is any one here who is not deeply interested in the matter of the movement from steam to electricity. It will possibly be a long while yet before the traffic lines will adopt electricity for handling their trains, but I have followed Mr. Farnham very carefully, and I feel that he has given us a very good paper, and I move a vote of thanks of this Club to Mr. Farnham.

The motion was unanimously carried.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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Vol. 19—No. 3 Chicago, November 20, 1906 $2.00 Per Year 25c a Copy

The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, November 20, President H. T. Bentley in the chair.

Among those present the following registered:

Allison, W. L.
Ames, C. P.
Barnes, C. A.
Bentley, H. T.
Blanchard, W. A.
Bothwell, G. A.
Bott, A.G.
Bower, J. G.
Broman, J. G.
Bryant, G. H.
Callahan, J. P.
Cardwell, J. R.
Carlton, L. M.
Carnev, J. A.
Chadwick, W.
Clark, F.H.
Coates, H. H.
Collier, F. P.
Cooper, G. A.
Cota, A. J.
Crawford, J. G.
Cunningham, A. J.
Derby, W. A.
DeVoy, J. F.
Dollv, J. M.
Dudley, R. C.
Endsley, L. E.
Ernst, F. B.
Feldhake, J. M.
Fowler, W. E., Jr.
Fromm, A. B.
Fry, C. H.
Goodnow, T. H.
Godwin, G. S.
Gowing, J. P.
Hadley, E. M.
Haig, M. H.
Herring, Richard
Hibbard, M. W.
Hill, C. P.
Hincher, W. W.
Holdrege, C. B.
Hopkins, G. H.
Hubbell, I. C.
Hungerford, L. S., Jr.
Isbester, G. C.
Jackson, E. J.
Jaschka, J. H.
Jeffries, B. H.
Jenks, C. D.
Kelly, J. W.
Kadish, R. B.
Klee, W. B.
Lancaster, J. R.
LaRue, H.
Lewis, J. H.
Little, J. C.
McCarthy, M. J.
McLelland, H. B.
Moore, P. W.
Neff, J. P.
Nicholl, F. M.
Osmer, J. E.
Ott, O. W.
Otto, Oscar
Park, H. S.
Park, S. T.
Parsons, Ottis
Peck, P. H.
Peterson, F. W.
Pratt, E. W.
Richardson, C. F.
Richardson. G. A.
Riddell, Chas
Russell, M. F.
Sharp, W. E.
Sipp, B. F.
Smith, R. D.
State, R. E.
Sturgis, R.
Symons, W. E.
Taft, R. C.
Thompson, C. B.
Thurnauer, G.
Taylor, J. W.
Taylor, T. I.
Townsely, C. A.
True, C. H.
Vissering, Harry
Wallace, W. G.
Wickersham, R. S.
Wickhorst, M. H.
Willcoxson, W. G.
Wright, Wm.
Wynne, J. H.

The meeting was called to order by the President at 8 P. M.

PRESIDENT BENTLEY: The first order of business is the approval of the minutes of the last meeting. These have been printed and distributed, and if there are no corrections will stand as printed.

The next order of business is the membership report. The Secretary will read it.

THE SECRETARY: Mr. President, I have the following list of applicants for membership received during the month:

Name Occupation and Address	Proposed by
F. J. Cooledge, J. L. Yale & Co., Chicago	J. W. Taylor
J. B. Freeman, Draftsman, Fitz-Hugh Luther Co., Hammond, Ind.	Peter Schreiner
M. LaQuay, N. Y. Air Brake Co., Chicago	M. E. Williams
J. M. Waugh, Waugh Draft Gear Co., Chicago	T. D. Henderson
D. J. Evans, Rail Joint Co., Chicago	G. A. Hagar
J. E. Simons, G. M. Fitz-Hugh Luther Co., Chicago	J. W. Taylor
J. R. Lancaster, Inspector of Matts. L. S. & M. S. Ry., Chicago	H. E. Smith
C. A. V. Axen, G. F., C. & N. W. Ry., Kaukanna, Wis.	H. T. Bentley
F. C. Peck, Standard Brake Stove Co., Chicago	F. P. Collier
C. P. Wright, Standard Brake Stove Co., Chicago	F. P. Collier
A. M. Stephenson, G. F. A. C. Torbert & Co., Hammond, Ind.	A. J. Cunningham
J. F. Layng, Engr. Westinghouse E. & M. Co., Chicago	G. H. Hopkins
W. K. Lavis, Piece Work Insp. C. B. & Q. Ry., Chicago	J. A. Carney
J. M. Feldhake, Supt. So. Side El. R. R., Chicago	G. H. Hopkins
W. C. Medland, Piece Work Insp. L. S. & M. C. Ry., Elkhart, Ind	M. T. McCarthy
L. E. Endsley, Purdue University, Lafayette, Ind.	W. F. M. Goss
Y. A. Haas, Fitz-Hugh Luther Co., Chicago, Ill.	F. B. Ernst
J. R. Thompson, Fitz-Hugh Luther Co., Hammond, Ind.	J. F. DeVoy
C. W. Millspaugh, Draftsmen A. T. & S. F. Ry., Chicago, Ill.	J. P. Neff
Jas. W. Cain, McCord & Co., Chicago, Ill.	W. J. Schlacks

RESIGNED.

O. W. Meissner — E. W. Kerr — A. B. Breeze

MAIL RETURNED.

E. D. B. Brown

DEAD.

John Saltar, Jr. — M. Dunn

Membership, October, 1906		1,297
Resigned	3	
Dead	2	
Dropped, mail returned	1	
	—	6
		1,291
New members approved by Board of Directors		20
		1,311

THE SECRETARY: Mr. President, that is all I have as regards the membership list.

PRESIDENT BENTLEY: Have you any other business?

THE SECRETARY: That is all I have.

PRESIDENT BENTLEY: Gentlemen, we have with us to-night a gentleman who is well known by every member of this Railway Club, and by every railroad man in the United States. He has taken the trouble to write a paper for us which I feel sure will be both interesting and instructive. The question of high steam pressures in locomotive service is the topic of this paper, and most of us know what we have been doing with the low steam-pressure engines, and what we are now doing with engines carrying the higher steam pressures. As we are rather late in making a start, I will ask Professor Goss to immediately open the paper, and I feel sure that no introduction is needed. Professor Goss. (Applause).

PROF. W. F. M. GOSS: Mr. President, and Gentlemen of the Western Railway Club: Those who attended the last meeting of the Master Mechanics' Association will recall that I presented there as a topical discussion a brief account of certain locomotive tests made under different pressures which had been run at Purdue. In concluding that discussion I suggested that a little later I might have more to present. I had in mind at the time the completion of a report then in progress to the Carnegie Institution of Washington, the completion of which was to constitute a part of my summer's work. When I reached my office in the fall I was met by a letter from Secretary Taylor, suggesting that the Western Railway Club would be glad to receive any additional statement that I might be prepared to make. I am here to-night in response to the invitation thus extended and that which I have to present is to be accepted as a continuation of my discussion before the Master Mechanics' Association. The paper I have prepared is as follows:

HIGH STEAM PRESSURES IN LOCOMOTIVE SERVICE.

The Carnegie Institution of Washington, D. C., some three years since, became a patron of Purdue University for the purpose of promoting a research to determine the value of high steam pressures in locomotive service. The work outlined under these auspices has now been completed, and final report has been rendered the Institution. This report will soon be published. Meantime the Institution has given its consent to the publication of a preliminary statement concerning methods and results.

1. *The Tests*—The tests outlined included a series of runs for which the average pressure was respectively, 240, 220, 200, 180, 160, 120 pounds, a range which extends far below and well above pressures now common in locomotive service. The tests of each

series were to be sufficiently numerous to define completely the performance of the engine when operated at any speed and for all positions of the reverse lever, possible with a wide-open throttle. So far as practicable, each test was to be of sufficient duration to permit the efficiency of engines and boiler to be accurately determined, but where this could not be done, cards were to be taken.

The first test was run February 15, 1904, and the last August 7, 1905. A registering counter attached to the locomotive shows that between these dates the locomotive drivers made 3,113,333 revolutions, which is equivalent to 14,072 miles. The completed record includes the data of 100 different tests.

2. *The Locomotive* upon which the tests were made is that regularly employed in the laboratory of Purdue University, where it is known as "Schenectady No. 2." The characteristics of this locomotive are rather generally known.

3. *Difficulties in Operating Under High Pressures.*—The work with the experimental locomotive has shown that those difficulties which in locomotive operation are usually ascribed to bad water, increase rapidly as the pressure is increased. The water supply of the Purdue laboratory contains a considerable amount of magnesia and carbonate of lime. When used in boilers carrying low pressure there is no great difficulty in washing out practically all sediment. The boiler of the first experimental locomotive, Schenectady No. 1, which carried but 140 pounds and was run at a pressure of 130 pounds, after serving in the work of the laboratory for a period of six years, left the testing plant with a boiler which was practically clean. Throughout its period of service this boiler rarely required the attention of a boiler-maker to keep it tight. Water from the same source was ordinarily used in the boiler of Schenectady No. 2, which carried a pressure of 200 pounds or more. It was early found that this boiler, which is of the same general dimensions as that of Schenectady No. 1, operating under the higher pressure frequently required the attention of a boiler-maker. After having been operated no more than 30,000 miles, cracks developed in the side-sheets, making it impossible to keep the boiler tight, and new side-sheets were applied. In operating under pressures as high as 240 pounds, the temperature of the water delivered by the injector was so high that scale was deposited in the check valve, in the delivery pipe, and in the delivery tube of the injector. Under this pressure, with the water normal to the laboratory, the injectors often failed after they had been in action for a period of two hours. The loss of tests through failure of the injector, and through the starting of leaks at stay-bolts, as the tests proceeded, became so annoying that, as a last resort, a new source of water supply was found in the return tank of the University heating plant. This gave practically distilled water, and its use greatly assisted in running the tests at 240 pounds pressure.

Probably some of the difficulties experienced in operating under very high steam pressures were due to the experimental character of the plant, and would not appear after practice had by gradual process of approach become committed to their use, but the results are clear in their indication that the problem of boiler maintenance, especially in bad water districts, will become more complicated as pressures are further increased. Since, taking the country over, there are few localities where locomotives can be furnished with pure water, the conclusion stated should be accepted as rather far-reaching in its effect.

The tests developed no serious difficulties in the lubrication of valves and pistons under pressures as high as 240 pounds, though the lubrication could not be done with a grade of oil previously employed.

With increase of pressure any incidental leakage, either of the boiler or from cylinders, becomes more serious in its effect upon performance. In advancing the work of the laboratory, every effort was made to prevent loss from such causes, and results were frequently thrown out and tests repeated because of the development of leaks of steam around piston and valve rods, or of water from the boiler. Notwithstanding the care taken, it was impossible under the high pressures to prevent all leakage. The best that can be said for the data under these conditions is that it represents results which are as free as practicable from irregularities arising from the causes referred to; that is, so far as leakage may affect performance, the results of the laboratory tests may safely be accepted as the record of maximum performance.

In concluding this brief review of the difficulties encountered in the operation of locomotives under very high steam pressures, the reader is reminded that an increase of pressure is an embellishment to which each detail in the design of the whole machine must give a proper response. A locomotive which is to operate under such pressure will need to be more carefully designed and more perfectly maintained than a similar locomotive designed for lower pressure, and much of that which is crude and imperfect, but nevertheless serviceable in the operation of locomotives using a lower pressure, must give way to more perfect practice in the presence of the higher pressure.

4. *The Effect of Different Pressures upon Boiler Performance* is summarized as follows:

1. The evaporative efficiency of a locomotive boiler is but slightly affected by changes in pressure, between the limits of 120 pounds and 240 pounds.

2. Changes in steam pressure between the limits of 120 pounds and 240 pounds will produce an effect upon the efficiency of the boiler which will be less than one-half pound of water per pound of coal.

3. The equation, $E = 11.305 - .221H$, in which E is the number of pounds evaporated from and at 212 degrees per pound of coal, and H is the pounds of water evaporated per foot of heating surface per hour, represents the evaporative efficiency of the boiler of locomotive Schenectady No. 2 when fired with Youghiogheney coal for all pressures between the limits of 120 pounds and 240 pounds, with an average error for any pressure which does not exceed 2.1 per cent.

4. It is safe to conclude that changes of no more than 40 or 50 pounds in pressure will produce no measureable effect upon the evaporative efficiency of the modern locomotive boiler.

5. *The Effect of Different Pressures Upon Smoke-Box Temperatures* was found to be as follows:

1. The smoke-box temperature falls between the limits of 590 degrees F. and 850 degrees F., the lower limit agreeing with a rate of evaporation of 4 pounds per foot of heating surface per hour and the higher with a rate of evaporation of 14 pounds per foot of heating surface per hour.

2. The smoke-box temperature is so slightly affected by changes in steam pressure as to make negligible the influence of such changes in pressure for all ordinary ranges.

3. The equation $T = 488.5 + 25.66\,H$ where T is the temperature of the smoke-box and H is the weight of water evaporated from and at 212 degrees per foot of heating surface per hour, possesses a high degree of accuracy for all ordinary pressures.

6. *The Engine Performance.*—The shaded zone upon Fig. 1 represents the range of performance as it appears for all tests run under the several pressures employed. It shows that the variation in performance for all conditions of running which are possible with a wide-open throttle scarcely exceeds five pounds. For purposes of comparison it is desirable to define the effect of pressure on performance by a line, and to this end an attempt has been made to reduce the zone of performance to a representative line. In preparing to draw such a line, the average performance of all tests at each of the different pressures was obtained and plotted, the results being shown by the circles on Fig. 1. Points thus obtained can be regarded as fairly representing the performance of the engine under the several pressures only so far as the tests run for each different pressure may be assumed to fairly represent the range of speed and cut-off under which the engine would ordinarily operate. It was the endeavor to have this range as wide as possible. The best results for each different pressure as obtained by averaging the best results for each speed at this pressure is given upon the diagram in the form of a light cross. These points may be regarded as furnishing a satisfactory basis of comparison in so far as it may be assumed that when the speed has been determined an engine in service will always operate under conditions of highest efficiency.

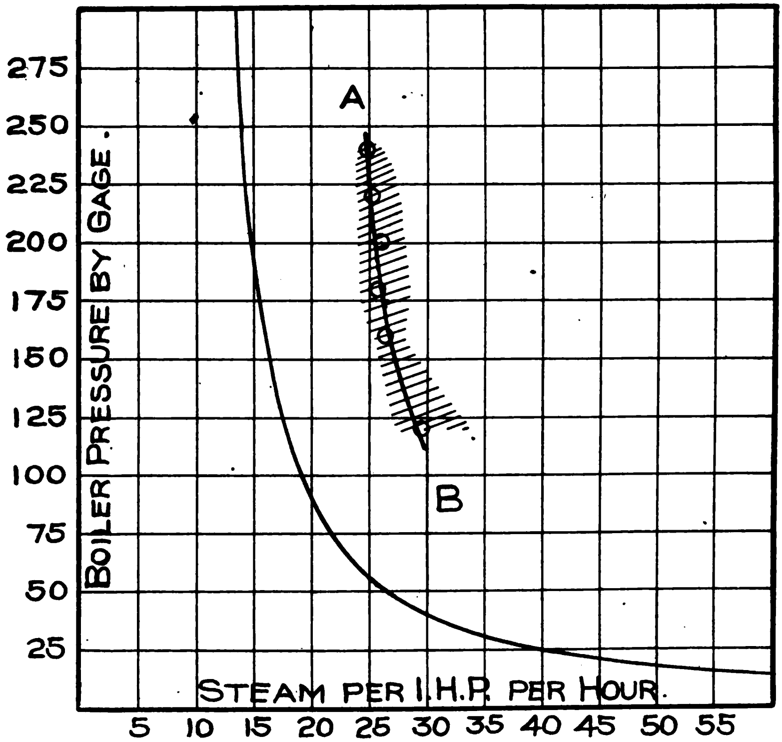

FIG I.

Again the left-hand edge of the shaded zone represents a comparison based on maximum performance at whatever speed or cut-off.

In addition to the points already described, there is located upon the diagram Fig. 1 a curve showing the performance of a perfect engine with which the plotted points derived from the data of tests may be compared.* Guided by this curve representing the performance of a perfect engine, a line A B has been drawn proportional thereto, and so placed as to fairly represent the circular points derived from the experiments.

That is, the curve A B is not drawn through the circular points; it is drawn from the line representing the performance for a perfect engine, but so located that it may, as nearly as may be, represent the circular points. Its agreement with the circular points is very close. It is proposed to accept this line as representing the steam

*This curve represents the performance of an engine working on Carnot's cycle, the initial temperature being that of steam at the several pressures stated, and the final temperature being that of steam at 1.3 pounds above atmospheric pressure. This latter value is the assumed pressure of exhaust in locomotive service.

consumption of the experimental engine under the several pressures employed. It is to be noted that it is not the minimum performance nor the maximum, but it is a close approach to that performance which is suggested by an average of all results derived from all tests which were run. Since its form is based upon a curve of perfect performance, it has a logical basis and since it does no violence to the experimental data, it seems to be justifiable.

7. *Coal Consumption.*—Accepting the curve A B Fig 1 as fairly representing the consumption of steam, the corresponding consumption of Youghiogheny lump coal for the several pressures employed is shown by Table I.

TABLE I.

Boiler Pressure	Coal		
	Per I. H. P. Per Hr.	Saved for each increment of pressure.	
		Pounds	Per Cent
240	3.31		
220	3.35	.04	1.2
200	3.40	.05	1.5
180	3.46	.06	1.7
160	3.53	.07	2.0
140	3.67	.14	3.8
120	3.84	.17	4.4

The last two columns of the preceding table show the diminishing value of the fuel saving which results from a given increment of pressure as the scale of pressure is ascended. For example, increasing the pressure from 120 to 140 pounds results in a fuel saving of 4.4 per cent., while a similar increment from 220 to 240 pounds results in a saving of but 1.2 per cent.

8. *Increased Boiler Capacity as an Alternative for Higher Pressures.*—Previous publications from the Purdue laboratory have shown the possibility under certain conditions of securing a substitute for very high boiler pressures in the adoption of a boiler of larger capacity, the pressure remaining unchanged. If, for example, in designing a new locomotive, it is found possible to allow an increase of weight in the boiler as compared with that of some older type, it becomes a question as to whether this increase in weight should be utilized by providing a higher pressure or an increase in the extent of heating surface. The results of tests supplemented by facts concerning the weight of boilers designed for different pressures and for different capacities supply the data necessary for an analysis of this question.

The full report presents with great elaboration the facts which

underlie the analysis. The results derived are well shown by Figs. 2 to 7 inclusive, in which the full lines represent the gain through increase of boiler pressure, and the dotted line the corresponding gain through increase of boiler capacity. It will be seen that starting with pressures which are comparatively low, the most pronounced benefits are those to be derived from increments of pressure. With each rise in pressure, however, the chance for gain through further increase diminishes. With a starting point as high

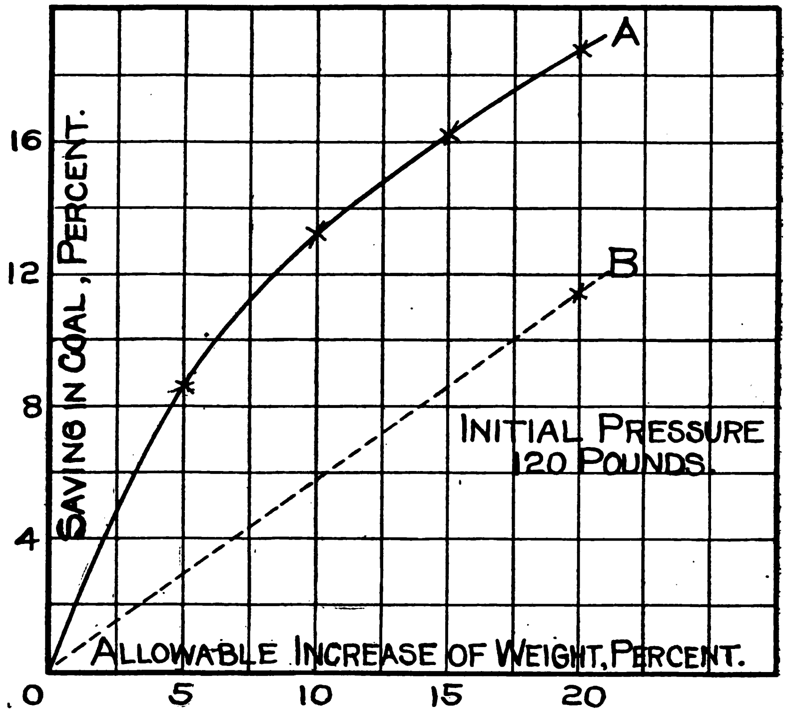

FIG. 2.

as 180 pounds, the saving through increase of pressure is but slightly greater than that which may result through increase of boiler capacity. For still higher pressures, the argument is strongly in favor of increase of capacity.

The fact should be emphasized that the conclusions above described are based upon data which lead back to the question of coal consumption. The gains which are referred to are measured in terms of coal which may be saved in the development of a given amount

of power. It will be remembered that conditions which permit a saving in coal will, by the sacrifice of such a saving, open the way for the development of greater power, but the question as defined is one concerning economy in the use of fuel. It is this question only with which the diagrams, Figs. 2 to 7, deal.

There are other measures which may be applied to the performance of a locomotive, which, if employed in the present case, would show some difference in the real value of the two curves (Figs. 2 to

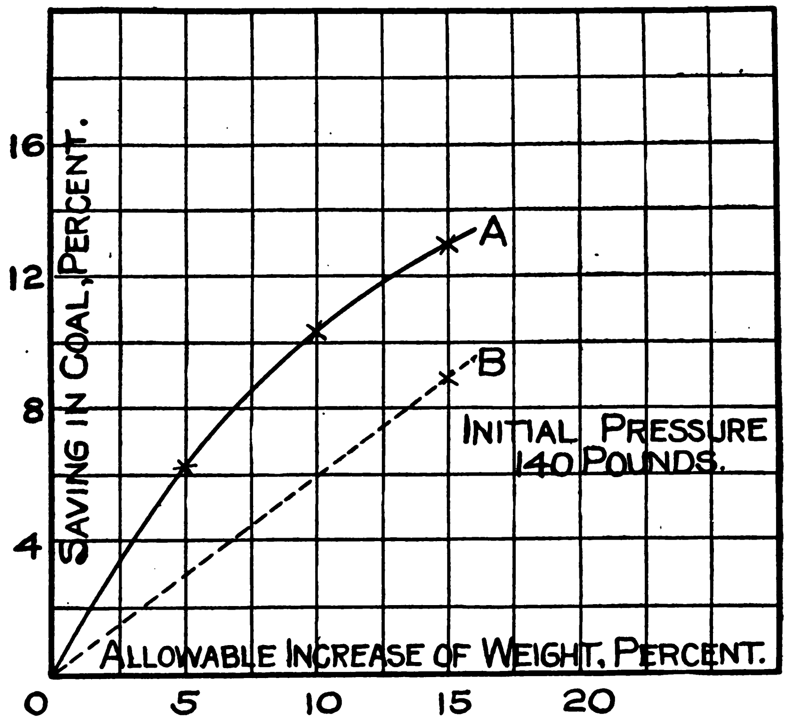

FIG. 3.

5). The indefinite character of these measures prevent them being directly applied as corrections to the results already deduced, but their effect may be pointed out. Thus, the extent to which an increase of pressure will improve performance has been defined, but the definition assumes freedom from leakage. If leakage is allowed to exist, the result defined is not secured. Moreover, an increase of pressure increases the chance of leakage so that, to secure the advantage which has been defined, there must be some increase in the amount of attention bestowed in

maintenance and this, in whatever form it may appear, mean expense, the effect of which is to reduce the net gain which it is possible to derive through increase of pressure. Again, in parts of the country where the water supply is bad, any increase of pressure will involve increased expense in the more careful and more extensive treatment of feed-water, or in the increased cost of boiler repairs, or in losses arising from failure of injector, or from all of these sources combined. The effect of such expense is to reduce

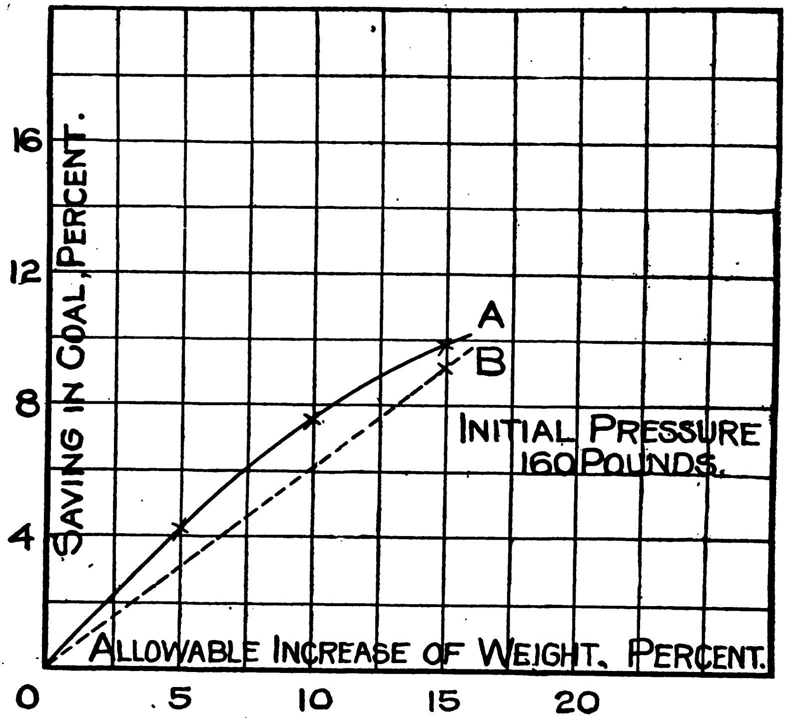

Fig. 4.

the net gain which it is possible to derive through increase of pressure. In view of these statements, attention should be called to the fact that the gains which have been defined as resulting from increase of pressure (Figs. 2 to 7) are to be regarded as the maximum gross; as maximum because they are based upon results derived from a locomotive which was at all times maintained in the highest possible condition, and as gross because on the road conditions are likely to be introduced which will necessitate deductions therefrom.

On the other hand, the relation which has been established showing the gain to be derived through increased boiler capacity is subject to but few qualifying conditions. It rests upon the fact that for the development of a given power, a large boiler will work at a lower rate of evaporation per unit area of heating surface than a smaller one. The saving which results from diminishing the rate of evaporation is sure; whether the boiler is clean or foul, tight or leaky, or whether the feed-water is good or bad, the reduced rate

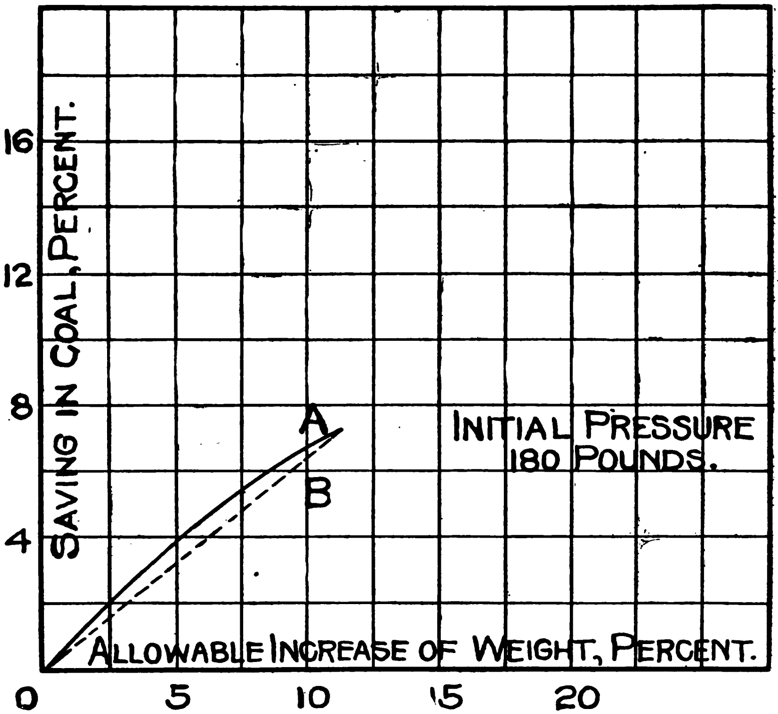

FIG. 5

of evaporation will bring its sure return in the form of increased efficiency. An increase in the size of a boiler will involve some increase in the cost of maintenance, but such increase is slight and of a sort which has not been regarded in the discussion involving boilers designed for higher pressure. Remembering, then, that as applied to conditions of service, the line A is likely to be less stable in its position than B, the facts set forth by Figs. 2 to 7 may be briefly reviewed.

Basing comparisons upon an initial pressure of 120 pounds (Fig. 2), a 5 per cent. increase in weight when utilized in securing a stronger boiler will improve the efficiency 8.5 per cent., while if utilized in securing a larger boiler, the improvement will be a trifle less than 3 per cent. Arguing from this base, the advantage to be derived from an increase of pressure is great. If, however, the increase in weight exceeds 10 per cent., the curve A ceases to diverge from B, and if both curves are sufficiently extended, they will meet,

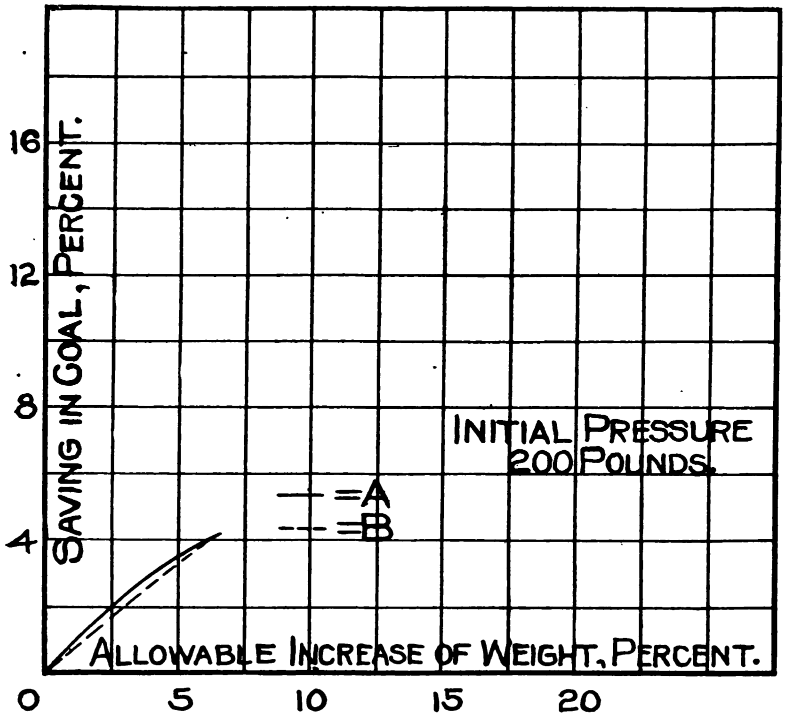

FIG. 6.

all of which is proof of the fact that the rate of gain is greatest for relatively small increments of weight.

Basing comparisons upon an initial pressure of 140 pounds (Fig. 3), the relative advantage of increasing the pressure diminishes, though on the basis of a 5 per cent. increase in weight, it is still double that to be obtained by increasing the capacity.

Basing comparisons upon an initial pressure of 160 pounds (Fig. 4), the advantage to be gained by increasing the pressure over that which may be had by increasing the capacity is very slight, so slight,

in fact, that a little droop in the curve of increased pressure (A) will cause the difference to disappear. As the curve B may be regarded as fixed, while A, through imperfect maintenance of boiler or engine, may fall, the argument is not strong in favor of increasing pressure beyond the limit of 160 pounds.

Basing comparisons upon an initial pressure of 180 pounds (Fig. 5), the advantage under ideal conditions of increasing the pressure as compared with that resulting from increasing the capacity, has a

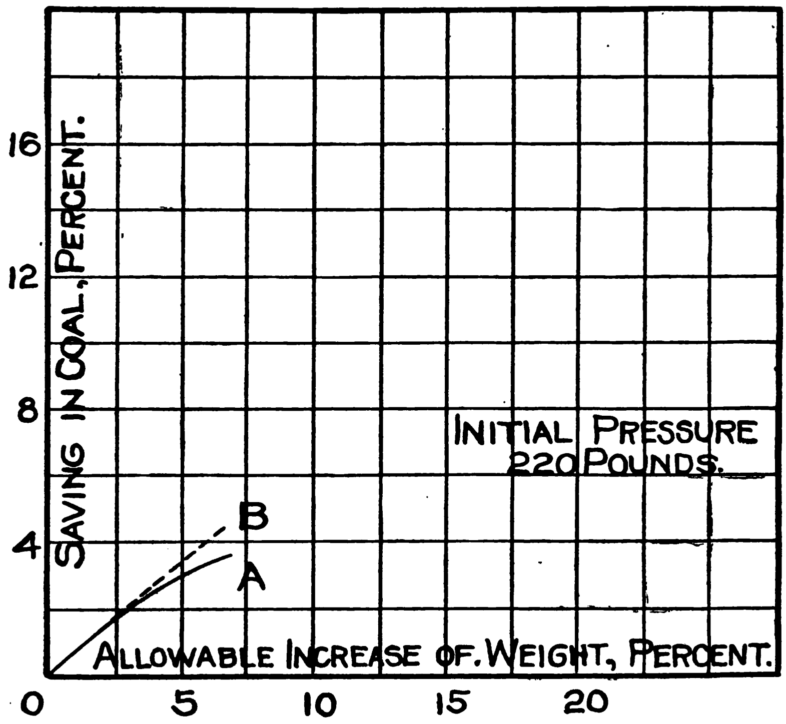

FIG. 7.

maximum value of approximately one-half of 1 per cent. In view of the incidental losses upon the road, the practical value of the apparent advantage is nil. In view of what has been said with reference to the stability of the curves A and B, Fig. 5, constitutes no argument in favor of increasing pressure beyond the limit of 180 pounds.

Basing comparisons upon an initial pressure of 200 pounds (Fig. 6), it appears that under ideal conditions, either the pressure or the

capacity may be increased with equal advantage, which in effect is a strong argument in favor of increased capacity rather than of higher pressure.

Basing comparisons upon a pressure of 220 pounds (Fig. 7), it appears that even under ideal conditions of maintenance, the gain in efficiency resulting from an increase of pressure is less than that resulting from an increase of capacity. In view of this fact, no possible excuse can be found for increasing pressure above the limit of 220 pounds.

8. *Conclusions.*—A summary of the whole work may be stated as follows:

1. Tests have been made to determine the performance of a typical locomotive when operating under a variety of conditions with reference to speed, power and steam pressure. The results of 100 such tests have been made of record.

2. The results apply only to practice involving single expansion locomotives using saturated steam. They cover only such conditions as may be maintained with wide-open throttle. Pressures specified are to be accepted as running pressures. They are not necessarily those at which safety valves open.

3. The steam consumption under normal conditions of running has been established as follows:

Boiler Pressure	Steam per Horse-Power Hour
120	29.1
140	27.7
160	26.6
180	26.0
200	25.5
220	25.1
240	24.7

4. The results show that the higher the pressure the smaller the possible gain resulting from a given increment of pressure. An increase of pressure from 160 to 200 pounds results in a saving of 1.1 pounds of steam per horse-power hour, while a similar change from 200 pounds to 240 pounds improves the performance only to the extent of .8 of a pound per horse-power hour.

5. The coal consumption under normal conditions of running has been established as follows:

Boiler Pressure	Coal per Horse-Power Hour
120	3.84
140	3.67
160	3.53
180	3.46
200	3.40
220	3.35
240	3.31

6. An increase of pressure from 160 to 200 pounds results in a saving of 0.13 pounds of coal per horse-power hour, while a similar change from 200 to 240 results in a saving of but 0.09 pounds.

7. Under service conditions, the improvement in performance with increase of pressure, will depend upon the degree of perfection attending the maintenance of the locomotive. The values quoted in the preceding paragraphs assume a high order of maintenance. If this is lacking, it may easily happen that the saving which is anticipated through the adoption of higher pressures will entirely disappear.

8. The difficulties to be met in the maintenance, both of boiler and cylinders, increase with increase of pressure.

9. The results supply an accurate measure by which to determine the advantage of increasing the capacity of a boiler. For the development of a given power, any increase in boiler capacity brings its return in improved performance without adding to the cost of maintenance, or opening any new avenues for incidental losses. As a means of improvement, it is more certain than that which is offered by increase of pressure.

10. As the scale of pressure is ascended, an opportunity to further increase the weight of a locomotive should in many cases find expression in the design of a boiler of increased capacity rather than in one for higher pressures.

11. Assuming 180 pounds pressure to have been accepted as standard and assuming the maintenance to be of the highest order, it will be found good practice to utilize any allowable increase in weight by providing a larger boiler rather than by providing a stronger boiler to permit higher pressures.

12. Wherever the maintenance is not of the highest order, the standard running pressures should be below 180 pounds.

13. Wherever the water which must be used in boilers contains foaming or scale-making admixtures, best results are likely to be secured by fixing the pressure below the limit of 180 pounds.

14. A simple locomotive using saturated steam will render good and efficient service when the running pressure is as low as 160 pounds; under most favorable conditions no argument is to be found in the economical performance of a machine which can justify the use of pressures greater than 200 pounds.

(Applause.)

President Bentley: Gentlemen, you have heard what Professor Goss has had to say about high and low pressures, and there is a whole lot in what he says, from the fact that a good many roads that formerly were in the habit of carrying 215 to 225 pounds pressure have cut their pressures down to 200 pounds. I am very glad to say that our road is in the van of progress; we don't carry higher than 200 pounds pressure, and therefore don't have some of the troubles that our high pressure competitors have.

The paper is now open for discussion, and we will be glad to hear from anybody who has anything to say on the subject. I don't want to have to call on anybody, because this is a subject in which we are all interested. I have the names of about fifteen people here; and if you don't get up and talk about this subject I will call on you anyhow. Mr. F. H. Clark, do you mind starting the ball rolling, please?

MR. F. H. CLARK (C B. & Q. Ry.): Mr. Chairman, I did not come here to start the ball rolling; in fact, I have not had an opportunity to study the paper as I ought, and as I expect to study it at some time in the future. The paper is such a one as we would all expect from Prof. Goss. It shows that the matter has been thoroughly and carefully studied and the results of the tests carefully considered. It seems to put the thing in such shape as to enable us to determine whether we should continue to use high pressures gaining a little in fuel economy and perhaps losing all or more than we gain with leaky packing and matters of that sort, but with it get the advantage of high power with a boiler of moderate size as compared with somewhat less power from a boiler of the same size, or equal power from a larger boiler. I think in many cases our boilers have reached weights beyond which we cannot very well go, and that we have all been inclined to build boilers with higher pressures, without fully realizing the disadvantages of higher pressure, as Prof. Goss has set forth so clearly. Prof. Goss' paper gives us a clue to some of the reasons for the difficulties we have had, and I believe that it may result in a change in the practice, that has become so general, of increasing the boiler pressures, and lead us to get a little more weight if we can and perhaps reduce the pressure.

PRESIDENT BENTLEY: Mr. DeVoy, do you have very high pressure on the Milwaukee road? If so, we would like to hear from you.

MR. J. F. DEVOY (C. M. & St. P Ry.): Mr Chairman and Gentlemen, I did not have any intention of discussing this paper, not because I haven't looked into it, but because I have carefully studied it and found that the results obtained in service confirm almost identically the results which are reported in the paper. I have studied the paper, and also the remarks made by Prof. Goss at the Master Mechanics' convention last time. Saturday morning I asked two young men in the mechanical engineer's office of the St. Paul Road to ascertain wherein this paper was wrong, and I put it to them pretty strongly that they must find something on which I could base an argument tonight. Those young men came to me about four o'clock, just before I left Milwaukee, and said: "If you care for veracity you had better let that paper alone; it agrees so nearly with what we have found that we cannot give you an argument," and that is the first time that I have come away

from Milwaukee for quite a while that I didn't have some reason for discussing a paper. The results that were tabulated today and Saturday were from simple engines, about 80 in number, and I believe our Master Mechanic who is here tonight, will bear me out in the statement, that I called on him to furnish me with all the data we had concerning high pressure engines, and also of boilers with high pressure, and I have been asking myself tonight, in view of what I have said to you, and in view of the fact that I cannot find any argument against the paper, I am asking this question: Would you attempt to recommend to any railroad of today a boiler pressure lower than 200 pounds? I have also asked myself the question: Why have seventy-five per cent. of the railroads, especially in the West, gone to a pressure of 210 to 225 pounds? I will make the statement tonight, which I have very carefully looked over, that I don't believe there is a balanced compound engine that does not carry a pressure of over 210 pounds. I have asked myself the question whether, in furnishing horse power by a boiler, the sediment which is given off, per horse power, mind you, now, would not be equally the same in a boiler carrying 100 pounds pressure as it would in one carrying 220 pounds pressure. I have asked myself the question as to whether the failures which occur in the side of a fire box are not caused from the fact that the water at that point is evaporated much faster than it should be; that the giving off of the sediment does not cause a lot of the failures.

Gentlemen, it is a hard thing for a lawyer to defend a man if he has been guilty of murder even though he got a good fee, and I don't believe that if I got the best fee I could be paid in Chicago, that I could other than verify fully all that is contained in the paper, and still at the same time I question whether I would recommend to anybody cutting down the pressure. And I know it is right to do it. (Applause and laughter.) I will say to you, gentlemen, that there is at the present time—you spoke of the St. Paul road; that an engine is being built, and I want to say to the Chairman, too, that it will be up to him to beat it, because it will be in competition with him, and it will have to run pretty fast if you beat it.

President Bentley: What pressure do you carry?

Mr. DeVoy: That boiler is being designed today with a view of carrying 225 pounds pressure, and I will not go back tonight and say that that should be cut down, simply because this is an age when you have got to do things, no matter how you do them. You are not always doing things because it is right to do them; you must get the greatest amount of power from a single unit that is possible. If any railroad in the city of Milwaukee said: "I will take you in Milwaukee at four o'clock and deliver you in

Chicago at six o'clock," you have got to do it or you have lied to the public.

Now, there is a whole lot to this question, and I honestly hope some man will tell me how I can go back home and do that which I believe to be right. I know that there are a number of gentlemen here who understand this just as well as I do, and I hope to be enlightened. (Applause.)

PRESIDENT BENTLEY: Mr. Seeley, whom you all know, was unable to be present tonight, having to go out of town, but he said: "I have left a first-class substitute in the shape of a gentleman named Mr. Goodwin, who will tell you all about it." We have heard from the C. B. & Q., and the Milwaukee, now we want to hear from the Rock Island. Mr. Goodwin.

MR. GOODWIN (C. R. I & P. Ry.): Mr. Chairman, the policy of the Rock Island for some little time past has been to cut down the boiler pressures on their engines, and about two years ago an order was issued to cut the steam pressure on all engines, carrying 200 or more pounds of steam, about 10 pounds. That gives the great majority of our engines now 190 pounds of steam; and on new equipment which has been bought in the last two years, including also passenger engines, the engines have been built to carry only 185 pounds of steam. There is one exception; the Pacific type engines, carry 200 pounds of steam, inasmuch as they are pulling our heaviest passenger engines. The road believes they are getting some very fine results from this cutting down of the pressure. We have been making a large saving in that line.

PRESIDENT BENTLEY: We have with us tonight Mr. M. J. McCarthy, Master Mechanic of the Lake Shore Road. We would like to hear from that railroad.

MR. M. J. MCCARTHY (L. S. & M. S. Ry.): Mr. Chairman and gentlemen, I have read over the paper presented by Prof. Goss and might say that I believe that it is a move in the right direction, but like our friend from Milwaukee, I don't know whether it is or not. We have on the Lake Shore, on the west division, running between Toledo and Chicago, some six or eight engines that were designed to carry 200 pounds steam pressure. We cut them down to 185, and have increased the cylinders about one inch in diameter, from 20½ to 21½. In the reports that I have received from the different road foremen, they claim that where the engine is not steaming, where they are carrying 185 pounds, and they drop down say 10 or 15 pounds, it is not as good an engine as when they lose the 10 or 15 pounds when they are carrying 200 pounds. They are not in favor of reducing the steam pressure for that reason. I don't know, at least I can't say up to the present time, that we have noticed any great amount of difference in the maintenance of the boilers, because we have been running under this system only four or five months.

President Bentley: Mr. DeVoy spoke of one road having balanced compounds increasing the pressure. I presume this was done to get a higher mean effective pressure in the low pressure cylinders. We have a gentleman here from the Santa Fe, where they use balanced compounds, and we would like to hear from him. Mr. Emerson.

Mr. H. Emerson (A. T. & S. F. Ry.): Mr. President, those having to do with locomotives are constantly being led into paths of barren idealism, and therefore when work like that of Prof. Goss brings us back with a thud to earth it becomes practically immeasurably valuable. I remember a few years ago hearing that 1,000 pounds steam pressure was an ultimate to be striven for, the reasons being that the higher the pressure the less the weight of engine, the less the water used, and the greater the coal economy. We were next led into compounds, on the plea that there would be less cylinder condensation and greater expansion, and therefore also less water and less coal used. An era is now beginning of superheated steam, and the same old prizes are held up, less weight, less water, less fuel. Prof. Goss convincingly shows that as to higher pressures there is nothing in it, that the practical economic limit is between 160 and 180 pounds. I wish that instead of limiting himself to simple engines he had at least indicated his opinion of compounds and of superheat. Is he to come to us five years hence and tell us that there is also nothing of practical value either in compounding or in superheat? I fear, however, that Prof. Goss himself is not yet wholly emancipated from the bug-a-boo of less coal consumption, from fuel economies to be attained by extraordinary refinements. He indeed points out how little the coal economy is, and somewhat apologetically surmises that increased repairs will more than offset it.

As a practical man, whose duty it is to make savings that show in the President's Annual Report, I wish emphatically to state that I no longer take any interest in advanced thermodynamic theories of which the reward is a theoretical fuel economy of 5 per cent. to 10 per cent. Recently I went into such a theory myself. I figured out the furnace conditions under which oil would, in burning, transmit most of its heat units to the water, and after rigging up an engine we ran a test. The actual average consumption of oil on the division per 1,000 ton miles was, during the month of the test, 89 pounds, but our experimental engine showed up with 126. There was not the least thing the matter with the theory, but leaky injectors, leaky fire-box and flues, ill-fitting valves, and I believe a steam turbine in the stack, got away with the steam so that it did not show up in ton miles.

This and a few other experiences led to a somewhat careful investigation of the fuel problem, and I found that for every pound

of fuel actually used to move ton miles, two pounds are lost between the mine and the furnace door.

Repeated tests show that 70 pounds to 80 pounds is required to move 1,000 gross ton miles over a virtually level road, yet repeated tabulations show that freight engines are charged more nearly with 230 pounds for this same service.

Between the limits of 180 and 200 pounds steam pressure Prof. Goss shows a fuel economy of about 5 per cent., or, on my basis of ton miles, an economy of 3.6 pounds per 1,000 ton miles. How can I give, then, a passing thought to this 3-6 pounds, when I am trying to find out what becomes of the 130 pounds, or two-thirds of the total fuel, for which I find no equivalent in 1,000 ton miles? What we need is more work like that of Prof. Goss, work that will demonstrate to us that ultra-refinements of theory are not the path along which immediate and easy economy is to be found. (Applause.)

President Bentley: Mr. Emerson, before you go, I did not find out how much pressure you carried in the boilers on those balanced compounds.

Mr. Emerson: I think it was 225 pounds, but I would like to ask Prof. Goss what his opinion is of high pressures with compound engines or with superheat.

Prof. Goss: Let me answer that question in the closing.

Mr. Emerson: I have to go very soon; I hope it will come before I leave.

President Bentley: It is too good a subject to close up so soon, Mr. Emerson. We have now heard from the C. B. & Q., the Chicago, Milwaukee & St. Paul, the Rock Island, the Santa Fe and the Lake Shore. We have with us a representative of the Chicago & North Western Ry., and would like to hear from him.— Mr. Thompson.

Mr. E. B. Thompson (C. & N. W. Ry.): Mr. President, when I read the proceedings of the Master Mechanics' Association, and Prof. Goss hinted that there were more good things to follow, I did not realize how much he would drop at the feet of the designers of locomotives; and I notice that in his paper tonight, in covering one of the questions that came to my mind in regard to the increased weight of boilers, he says that the final report will show what can be done in that line. The road with which I am connected is so apparently bound to maximum weight of locomotive that the problem of getting increased weight in our boilers is certainly a serious one, and I look forward with a good deal of pleasure to the final report.

President Bentley: We have heard a good many things from Prof. Goss about the enormous leaks that take place in the boilers, due to the increased pressures carried, and it might be possible that somebody here who has some knowledge, as a man in charge of.

boilers, could give us a little data on that and say what his experience has been in regard to comparisons between engines carrying 160 to 180 pounds pressure and engines carrying from 180 up to 200 or 210 pounds. I would like to hear from some gentleman who is closely connected with a boiler shop. Mr. Kelly, you are familiar with the difficulties under which you are laboring now; can you tell us as to whether you are having very much more trouble with the increased pressure than you did when you were carrying lower pressures?

Mr. J. W. Kelly (C. & N. W. Ry.): Mr. Chairman, the subject of high pressure in locomotive service is a very important one. We have today in our boiler shop an engine about two years old, that carries 200 pounds pressure, which is receiving a fire box. Standing alongside this engine is one 19 years old that carries 160 pounds pressure, which is also receiving a fire box. On some of the divisions of the railroad with which I am connected, where the water is not treated the side sheets of the high pressure engines have to be renewed in from one to three years, whereas engines carrying 140, 150 and 160 pounds pressure last from five to fifteen years before renewing side sheets. High pressure and bad water is a very poor combination; side sheets soon develop cracks which require the attention of a boiler maker continuously to keep them tight. It is about as our friend, Mr. DeVoy says; it is not what we think but what is required to keep pace with the demand. I am in favor of reducing the pressure providing the management can see their way clear to do so.

President Bentley: I think Mr. Kelly hit the right nail on the head when he said—and also Prof. Goss mentions it particularly in his paper—that high pressure and bad water make a bad combination. I remember when I noticed this statement about cracked side sheets in a fire box of an engine at Schenectady after having only made 30,000 miles, I thought that is very familiar; I used to have that right along. In Iowa before we had purified water we used to give engines half side sheets and new flues every thirty to forty thousand miles, but after the water was put in pretty good condition on account of being purified, why, we thought nothing now of making 150,000 to 200,000 miles with the same firebox and side sheets and the same flues. So that I believe it is a bad thing to have in combination high pressure and bad water. If we can eliminate one or the other, I think our difficulties are going to be very materially reduced.

I notice my friend Mr. Smith here tonight; he has had a good deal of experience out in the West with bad water and high pressure engines, and I would like to hear from him.

Mr. R. D. Smith (N. Y. Central Lines): Mr. Chairman, I believe the Western Railway Club is to be congratulated in having

among its members one who can write so able a paper. I noticed that Prof. Goss made mention in two or three places of the checks stopping up and injectors giving out after a period of only two hours' work. Of course it is interesting to note the difficulties of this sort experienced in experiments because we know they are multiplied in actual service, but perhaps many of them would give way if we were better lined up, or rather, if we did better work on our engines. The most trouble experienced from high pressure, as I see it, is due to leakages about pistons and valve stems and relief valves and things of that sort. Isn't it just possible that rather than cut down the pressures we ought to be improving those parts that are giving us the trouble? I am not in favor of reduced pressures. It seems to me that it is taking a step backwards. I have not studied the paper as thoroughly as I intend to later on, but I gather from reading it that the reductions in pressure have made only a slight saving in coal consumption. If by the use of this small additional amount of coal we can haul more tonnage, it seems to me we won't have a very good argument to go before our managers to recommend reducing steam pressures. I don't believe, if I were called on to recommend the proper steam pressure for an engine that I would feel I was doing right or what I thought was right in recommending a less pressure than 200 pounds.

MR. P. H. PECK (C. & W. I. R. R.): Mr. President, railroad men, like most everybody, have fads and fancies. This question of high pressure is a fad and a fancy. I know of officials ordering new engines with 18-inch cylinders, to carry 200 pounds of steam. Why don't they put on a little larger cylinder and be done with it, and have a better, and more economical engine? In this section of the country we don't get one-third of the wear out of a high-pressure engine that we do out of one that carries 140 or 150 pounds of steam. The pressure wears the corners of the fire box out and cuts the rivets in the bottom of the fire box, just like a rat-tail file. It is just like the fad and fancy of twenty years ago for short fire boxes; they placed the flues only nine inches from the grates. It was dead wrong. And I ordered some—because I thought I would be in the swim with the rest of the boys, but I made the same mistake the others made. I thought those who had experimented in that direction knew something, but they didn't know any more than I did. (Laughter and applause.)

MR. EMERSON: Mr. President, just before I go out,—you asked me a question that I did not fully answer.

On the A. T. & S. F. Ry., for four years past, records have been kept of engine repair costs by individual engine and these records have been tabulated as to road units, and their cost; road units being the mileage of an engine multiplied by its weight on drivers. The mileage shows the extent to which the engine was in service

and, as a matter of course, an engine weighing 100 tons should cost more to maintain than an engine of 50 tons.

To find the cost per road unit, the total maintenance expense of an engine from one heavy shopping to another is divided into the road units for the same long or short period. These road unit figures on the A. T. & S. F. Ry. are tabulated as to classes of engines, divisions, shop repairs, and also subdivided as to light and running repairs on the one part and heavy and general on the other, each being about 50 per cent. We have also road units as to relative proportions of labor and material charges.

It is therefore easy for me to answer Mr. Bently's question as to the pressures and repair costs of our different classes of engines.

Our road unit costs in the fiscal year 1904-5 were for the whole system $106.90, for the fiscal year 1905-6 they have been reduced to $78.61.

The highest division, Los Angeles, California, was equipped with simple engines of low pressure and they showed a road unit cost of $159.20. The divisions of least cost on our system are Illinois and Missouri where the costs per road unit are now down to about $70.00 and where of 150 engines, 39 are simple with pressures of 150-180 pounds and 111 are compounds with pressures of 220 to 225 pounds.

From this compilation it appears that our engines with 220 pound pressure are costing less than half per road unit what the simple low pressure engine costs.

There is, however, no warrant for the conclusion that the high cost of maintenance of the California engines is due to their low steam pressures and to their being simple, nor that the low cost of the engines on the divisions east of Missouri is due to the fact that they are compound and use steam at high pressure.

Repair costs were high in California owing to wages, oil burning, branch lines, hills, etc., etc., and costs were low on the far Eastern division because wages were lower, material cheaper, branch lines few, grades few, shops and roundhouses at that time under more economical administration.

Examples follow of coal burning engine types, boiler pressures, new road unit costs.

S simple. C compound. V. C. Vauclain compound. T. C. tandem compound. B. C. Balanced compound.

Class	Type	Weight on Drivers	No of Shoppings	Boiler Pressure	Road unit Cost
1200	4-6-2 S	147,400	18	220	$ 50.29
900	2-10-2 T.C.	234,580	73	225	73.50
256	4-4-2 B. C.	101,420	11	220	76.36
566	2-6-0 V. C.	135,000	66	200	80.77
1050	2-6-2 V. C.	141,690	170	220	91.69
41	4-4-0 S	63,500	41	150	94.96
23	4-4-0 S	67,700	9	150	101.37
151	4-6-0 S	96,500	36	180	113.08

I accept without reserve Prof. Goss' deductions, yet our own compilations show to what a very remote extent boiler pressure effects repair cost. Our simple engines carrying 220 lbs. cost us less than any other engines, only $50.29. Our simple engines carrying 150 pounds cost us from $94.96 to $101.37 or double as much. One simple engine carrying 180 pounds cost $113.08. Our compound engines of all types, balanced, Vauclain, Tandem, Passenger or Freight carrying 220 to 225 pounds cost from $73.50 to $91.69, or less than any of the low pressure engines.

These curious practical results so much at variance with theory show that the man counts for far more than the particular type of engine or the steam pressure.

In the order of their importance the following affect the cost of maintenance of an engine—Design, materials, road bed, engineer and fireman, dispatching, round-house care, shop care, water, coal, steam pressure. Undoubtedly if all these were what they should be, road unit cost might not exceed $25.00 as against the $50.00 to $200.00 of actual practice, on the different roads of the United States, but on the other hand they might be even higher than $200 unless the men in control so inspire their subordinates as to make each one get the best out of all that is under them, and the human element is more important than anything else.

Mr. DeVoy: Mr. Chairman, I want to beg your indulgence—I must go at ten o'clock and it is pretty nearly that time now, but I want to say a word or two more. Gentlemen, it is a positive fact that today the piston-rod can be packed with 225 pounds just as easily as it can be packed with 180 pounds of steam. It is a positive fact that there are packings today that will wear with 200 pounds of steam equally as well as they will with 180 pounds of steam, and last two years. It is a positive fact that there are today throttle packings and air-pump packings which will outlast any of the old packings. That is due to the time and thought which has been given in developing such packing.

Now, I have not learned as much as I wanted to, and that is the reason I am asking a few more questions. It is a positive fact, if any man takes the time to figure it out, that the increased weight of engines is, to a great extent, destroying the rails with such rapidity that it is becoming an alarming problem in the maintenance of road-beds, bridges, etc.; and when the attempt is made to further increase the weight of engines, you will meet very strongly with the argument that if, to reduce your pressure, and consequently increase the weight of your engines,—which, I take it, is about what is assumed in the paper;—if 180 pounds pressure is used, it will necessitate increasing the weight of the cylinders—I am giving figures offhand—and if I could only stay until Prof. Goss had gotten through I would go home tomorrow and start in to design an engine along the lines he has suggested, and then I would know about the

percentage of increase in weight, but approximately—you might increase the weight of the cylinders from 5 to 8 or possibly 10 per cent. I don't believe that the increase in the size of the boiler will amount to as much as that, for this reason: In designing a boiler for 220 pounds pressure to take the place of one of 200 pounds pressure, in order to obtain the greatest efficiency of the boiler or the proper factor of safety, the increasing of the sheets, to be exact, from 11/16 to 13/16,—and I don't believe that that is going to handicap you a whole lot. My whole thought runs along one line, and that is this: Can you develop a horsepower and deliver it at the time you want it, with a boiler with 180 pounds pressure, and still maintain your boiler as it should be.

Now to answer some of the questions myself, I found that the increased cost of maintenance on boilers due to the increase of pressure from 160 and 180 to 200 pounds was in some cases 25 per cent.; understand me, 25 per cent. more in the maintenance of boilers due to that increase in pressure; and those figures cover about eight years; and, as I said to you before, I know from what investigation and study I have made that we should go back, but I wish—I say as the poor sinner did: "Oh, Lord, show me the way!" I don't even know what argument to put up to our people to cut down the pressures. As far as leakage is concerned, that does not amount to anything at all; that can be taken care of. I believe every word in the paper is the gospel truth, and I hope some one will be able to show me the way to cut down pressures.

Prof. Goss: Mr. Chairman, I think I might say just a word to satisfy Mr. DeVoy in response to one question which he has raised. It is not proposed to make heavier boilers for the sake of getting them larger. That would make locomotives heavier. It is proposed only as a first step to save weight by reducing the thickness of the sheets, and by lightening the staying and riveting. The weight thus saved will, in a slight degree only, be counterbalanced, as has been suggested by Mr. DeVoy, by an increase in the weight of the cylinders and of the pistons. My full report will show the relation of these weights for different pressures. I need only say now that the net saving in weight which results from a reduction of pressure is material. Having thus lightened the boiler by designing for a lower pressure, the next step is to restore it to its original weight by increasing its size. That is, I merely propose to commute weight saved by reducing pressure into weight to be used in securing additional heating surface.

President Bentley: The trouble with Mr. Peck is you never know when he is joking. He made a statement just now that seemed to indicate that with the 140 pound pressure engine he was doing as much work in the olden days as he does now with his engine carrying 200 pounds pressure, but he has a whole lot more trouble with his engine than with the higher pressure. Now isn't it a fact

that if we were to figure on the actual tonnage handled by each engine, that we would find that we would have very little more trouble, considering the tonnage hauled, with the engine carrying the 200 pound pressure than we would have with the engine carrying the 140 pound pressure?

Mr. Jeffries, of the Wabash, is here, and that is one road we haven't called on yet. We would like to head from him. Mr. Jeffries, having had experience as a locomotive engineer, will probably be able to tell us which he would rather have, the pointer sticking up at the 200 pound pressure mark, or away down at the 180 pound pressure mark.

Mr. B. H. Jeffries (Wabash R. R.): Mr. Chairman and gentlemen, Prof. Goss' paper has solved what has been to me a conundrum for a long time. I remember some years ago I used to run an engine that carried 180 pounds of steam and an 18x24 inch cylinder, and the competition among engineers was very hot at that time as to who could make the most economical performance, and the amount of coal saved. I carried the banner over there for quite a while, and ran that engine as low as 8.2 pounds per car mile, if I remember rightly. That engine carried 180 pounds of steam, and her performance was marvelous. Of course we did not haul the trains those days we haul now; the trains were not as heavy, but the remark has been made, and undoubtedly you have all made it, "Gee, if we could get these big ones to do the work the little ones did in the same proportion, wouldn't they be dandies?" Well, that is true; they don't do it, they don't do the work the little engines did in proportion to their size. I have an engine now that has a 21x28 inch cylinder and weighs about 197,000 pounds and carries 200 pounds of steam, and I venture to say she is as good as any engine of that class that runs into this town, but her coal consumption will run about 15 pounds per car mile, with those big trains, and I venture to say that with the same tonnage that the little engine pulled that she will consume almost twice as much coal. Certainly, there is something in that; it must be in the pressure.

Another thing, with high pressure or low pressure, concerning the boiler we all know what scale is. There are two different kinds of scale; there is this hard scale that nothing penetrates, and you gentlemen find that in these high pressure boilers; you will find the scale lots harder than in low pressure boilers, consequently your engines won't run as long carrying the high steam as they will with low pressure; you will find a harder scale in them, and the hard scale is what causes the damage.

President Bentley: I was under the impression that nearly all the scale was thrown down at a temperature of about 302 degrees. I don't know whether I am actually correct on that, but if so, the increase in pressure would not make a very great difference in that direction.

Mr. Symons is here to-night; we would like to hear from him, if he will give us a few words on this subject.

Mr. W. E. Symons: There are several Symons in Chicago; I don't know whether I am the one invited or not.

President Bentley: Excuse me, I think you are the only one in the room, Mr. Symons.

Mr. Symons: Thank you. This very interesting and scientific subject has been presented in such a scholarly manner that, to my way of thinking, there is no room whatever for any addition to be made to it, or any criticism. It appeals to me considerably in the same manner, or standpoint that it always does when I have the opportunity of listening to a lecture or a discourse from some one who is eminently fitted for and has had at hand facilities for analyzing a subject in a manner far superior to any advantages which I have had at my command. Therefore it has been a mental feast to myself to listen to the paper, and I will also add that the discussions are interesting and instructive.

Prof. Goss's presentation of this subject here to-night, however, prompts the suggestion that the conclusions reached may possibly through an erroneous impression cause some scientific and technical, also operative and practical men to go farther backward, or in the direction of reduced steam pressure than they have formerly progressed, coming forward with increased steam pressure. In making this suggestion, I recall what appears to have been a custom among the class of men above mentioned in their treatment of subjects of this kind both from a scientific and practical stand-point, in that, they have frequently followed, as a result of habit, one particular line of thought to the exclusion of all others, when a proper analysis of the real subject would require harmonizing conflicting interests, in the application of such fixed or unalterable conclusions as local conditions would permit. As has been properly said this evening a few years ago we went from low steam pressures to the high, first to the high pressures of single expansion engines, and by gradual progress to the compound locomotive, which came into quite general use, and was highly endorsed by most all of the prominent engineers and operating men, who had to do with the operating or building of locomotives, and the compound principle which gave such excellent results was predicated upon the highest steam pressures reached in locomotive operation.

The points brought out by Prof. Goss's paper here this evening as to the losses or negative effects resulting from those increased pressures were largely, if not completely lost sight of, and in many instances were completely ignored in items of expense of maintenance of locomotive boilers, and in many instances, I am inclined to think, it would be safe to say that, possibly engines operated under the high pressures reached at that time, and in use at the present time were the result of these endorsements placed in service in cer-

tain localities and under certain conditions to which they were not adapted, and under which engines with lower steam pressures would have proved much more efficient and economical. Again the negative results from the increased increment of pressure largely results, from the fact, that other portions of the complete machine, particularly the machinery, did not receive proper attention in the way of providing for operating a steam engine with increased pressures; in other words, the entire locomotive was not improved in a general way to harmonize with increased steam pressures. This was particularly noticeable in such essential features as metallic packing for piston rods, valve stems, and other joints or connections, where it was essential to the successful operation of the engine that they should be kept perfectly tight. The same devices and methods were frequently employed with 215 and 225 lbs. steam pressure, that had been found satisfactory with steam pressures of 140 to 160 lbs.; the result was usually a failure and frequently the *engine* was condemned on account of unsatisfactory results that were directly chargeable to some particular detail, which had not been given the attention it deserved.

I recall having taken service a few years ago with a system of railways having in its locomotive equipment about 250 engines, the maximum steam pressure carried on any of the engines, (except about one-half dozen recently purchased) was 160 lbs. It became necessary to add considerable power, and in the purchase of this power all the boilers were built under the very strictest specifications as to pressure, and carefully conducted tests were insisted upon at the locomotive works prior to acceptance, the limit being 200 pounds. The engines were placed in service with a reduced pressure of 20 lbs. or 180, and although some of them were assigned to a very bad water district where boiler repairs were the most important items, these engines under the conditions above described gave practically no trouble whatever. A record kept for some considerable period of time showed that the expense of maintenance was far below that of other engines, the boilers of which were carrying the maximum amount of steam for which they were constructed, and in making this comparison due allowance was made for the respective ages of the boilers.

I, therefore, think, that while the paper, as I have previously said, is to my mind perfect, and not open to either criticism or flaw, yet on account of the high standing of its author before the engineering and the railroad world, I fear it may, through misconstruction, have some adverse effect on those who are now successfully operating locomotives with high steam pressure, both simple and compound, while in fact, it shouldl have a most favorable effect, inviting a thorough analysis of all known complaints, defects, or adverse results in the use of high steam pressures by engineers, designers, builders and operating officers, that a conclusion based on

actual facts as to adverse results, and a proper remedy therefor be arrived at. This would doubtless add much in improved material design, construction and operation of locomotives.

One question I would be glad if the author would kindly answer in his closing remarks, and that is in connection with the side sheets of the Schenectady boiler, one of which I note from the paper had side sheets removed a short period after being placed in service. It would be interesting to know if there was any difference in the material used in the two fire boxes either in dimensions or as shown by physical test or chemical analysis (Applause).

PRESIDENT BENTLEY: Mr. Wickhorst, can we hear from you, please?

MR. M. H. WICKHORST (C., B. & Q. RY.): Prof. Goss has apparently brought to a conclusion one of the fundamental questions in locomotive design, and if I understand rightly, if we have a certain weight to put into a locomotive as a whole, his idea would be and his results seem to show that we had better stick to about 180 pounds pressure, and then instead of putting weight into a thick shell for a high pressure, use a somewhat larger shell and a few more tubes, and use a little larger cylinder. I think, if I understand rightly, he would not take any locomotive in service carrying 200 and cut the pressure down to 180 or 190 and expect to get the same service.

Regarding the matter of boiler leakages, some of us have given this matter some little attention during the past few years, and we are beginning to think that we are not afraid of high pressures so far as being able to maintain boilers in good service is concerned; we think there is good reason to hope that after a while we will be able to handle 220 pounds if necessary, and be sure that our locomotive boilers will continue in service successfully. However, if we can get along with 180 pounds, why, so much the better; our troubles will be just that much less.

PRESIDENT BENTLEY: When we started this evening there seemed to be a certain amount of modesty among the members about getting up and telling us what they knew about this subject. I therefore made up a list of people who, I knew, could enlighten us, and have already called on thirteen or fourteen of them, and obtained lots of useful information. I would like to have some volunteers, but if these are not forthcoming, will have to continue down my list. Mr. Little, can we hear from you?

MR. J. C. LITTLE (C. & N. W. RY.): Mr. Chairman and Gentlemen: In looking over one of our boilers on the Northwestern today, a boiler that carries 200 pounds pressure, with a view of making it a 180-pound boiler, we found that it would require an increase in weight somewhere in the neighborhood of 5 per cent for the 180-lb. boiler over the presnt 200-lb. boiler. As we are limited

to our present weight, it would be next to impossible to put an 180-lb. boiler in the engine without reducing the tonnage.

Mr. P. H. Peck (C. & W. I. Ry.): Mr. President, just one remark before I go. We have known Prof. Goss a good many years, and he never speaks before this Club but what he says something. He tells what he knows and what he has found out by actual experience. Now Prof. Goss says to-night that by carrying a lower pressure we will save expense in repairs and maintenance, which we all know, and we will have a better engine. It is with the railroads now just like it was with millionaires a few years ago; it was hard to find a man that had a million, and now there are a hundred thousand of them. The railroads wish to procure engines with high pressure in order to handle more cars per train and by so doing they hope to save one train crew with possibly four or five engines. That is all right as far as it goes—it shows up cheaper in the train service, but where they save two men with possibly five engines, it takes about two more machinists and one boiler maker in the machine shop to keep the engines in service, so what they gain in the train service they lose in the maintenance of engines besides reducing the life of the boilers considerably. I think the sooner we find out what the economical point of boiler pressure is, the better off everyone will be. Prof. Goss says that after we get past 180 pounds of steam we have passed the economical point. He has made some very elaborate tests in this line and I have no doubt his views are correct.

Mr. W. Forsyth (Railway Age): Mr. President, I think we all agree with the conclusions of the paper, that there is very little to be gained by increased pressure, and yet I think the discussion has shown that there is a reluctance to reduce boiler pressure, and the reason of that is because you cannot sacrifice the power obtained by high pressure. I would like to discuss briefly the relation of the power and weights of locomotive boilers with respect to their design.

The suggestion that boilers be made larger in order to obtain greater capacity with medium pressures cannot have much effect on the future locomotive design, for at present it is the common practice with all locomotive builders to make the boiler as large as it possibly can be, and fit it into the general design. The result of this practice is imposing a weight on the rail of 30,000 pounds per driving wheel, and it is doubtful if such loads can be successfully used in general practice, or if they can be exceeded without material injury to the track. Bessemer steel rails are now failing as a direct result of overloading, and metallurgists have recognized the fact that in order to make rails which will successfully stand such wheel pressures, resort must be had to some other process of steel manufacture. The constant increase in weight of locomotives is for the purpose of obtaining *more power,* and it is contrary to the tendencies

and traditions of American railway practice to *go back,* or *let up,* in any way. Any measure which will reduce locomotive power, as is inevitable if boiler pressures are reduced, is not likely to ultimately prevail. If the principal objection to high pressures in the present type of boiler is due to bad water, it would certainly be more economical from an operating standpoint in most cases to purify the water than to reduce boiler pressure, and it would doubtless be found that when a good system of water purification is installed there will be no serious difficulties attending the use of a pressure of 200 or 220 pounds.

It does not seem possible that American locomotive builders will be satisfied to restrict the power of locomotives by adopting a limit for the boiler pressure, but as more power is demanded and the limit of weight is reached in fire tube boilers, it will be necessary to resort to a different type of boiler. The evident solution of this problem is the use of the water tube boiler. All the navies of the world have adopted this type of boiler for the very reasons which should recommend it for the future locomotive, namely, the possibility of carrying greater pressure with safety and without leakage or failures of flat surfaces, and the further advantage of having a much less weight per H. P. than is found in the ordinary cylindric boiler.

It may be interesting to give some figures relating to the weight and power of boilers of different types: In an 8-wheel American type locomotive having 20x26-inch cylinders and 78-inch wheels and a total weight of 132,000 pounds, the boiler weighs 34,100 pounds, or 25.8 per cent of the total weight of the locomotive. A simple Atlantic engine with 20½x26-inch cylinders and 79-inch wheels, weighing 176,000 pounds in working order, has a boiler which weighs 45,200 pounds, or 26 per cent. In a Decapod engine, weighing 260,000 pounds in working order, the boiler with tubes weighs 66,313 pounds, or 33 per cent. It is thus seen that the larger the engine, the greater per cent of its total weight is found in the boiler. The boiler in the Atlantic engine mentioned above will develop a maximum of 1,500 cylinder H. P., so that the weight of the boiler is 30 pounds per H. P. The Decapod engine will probably not develop over 1,600 H. P., and the weight of this boiler is 41 pounds per horse power.

The advantage of water tube boilers on account of their lightness and strength has been utilized in automobiles to such an extent that they carry a boiler pressure of 595 pounds, use superheating to the extent of 298 degrees, and an automobile boiler tested to 45 H. P. weighs only 315 pounds, or 7 pounds per H. P. In marine service we find that the boilers used on Japanese war vessels carrying a pressure of 300 pounds per square inch weigh only 10 pounds per H. P., or only one-third to one-fourth the weight per H. P. of locomotive boilers. For the actual application of water tube boilers to

the locomotive we have an example in the Robert boiler, which weighs 17,820 pounds, with a capacity of 800 H. P., or 22.2 pounds per H. P. It would appear, therefore, that by the use of water tubes in locomotive boilers it would be possible to reduce the weight per H. P. from one-half to two-thirds, and practically no restriction would be made on boiler pressure. The use of the superheater on locomotives shows that there is little difficulty in using steam in locomotive cylinders at a temperature of 600 degrees, and the temperature of saturated steam at 500 pounds pressure is far below this. It is possible that the introduction of the electric locomotive, which is better adapted for high speeds and greater power than the steam locomotive, will prevent the gradual change of the locomotive into an engine carrying much higher pressures than have been used heretofore, but it appears that a point has been almost reached when any attempt to obtain greater power from steam locomotives must be accompanied by a change in the type of the boiler to one which will have less weight per H. P. (Applause.)

President Bentley: Gentlemen, the hour is not late. The Secretary has just whispered in my ear "I think this is the most interesting meeting we have ever had," and I want to endorse that statement. I have been coming to these meetings for a good many years, and I never remember such an interesting subject. The topic was well chosen and the discussion has been very interesting and entertaining. I would like to ask if there is anybody else that wants to bring up any questions? if not, we will ask Prof. Goss to close the paper.

Mr. Ira C. Hubbell: Mr. President, I would like to ask one question regarding the remarks of Mr. Forsyth, in which he calls attention to the weights of the boilers per horse power in connection with automobile service and in connection with the Japanese warships. I believe that the engines using the steam generated by the boilers of the automobiles referred to are compound condensing, and that the engines of the warships are triple or quadruple expansion condensing. Is it not possible that we might accomplish an increase in the horsepower development of the locomotive boilers of given dimensions through a more correct utilization of the steam generated by the boilers in the cylinders of the locomotives, and thus proportionately reduce the weight of the boiler per horsepower developed by the locomotives?

President Bentley: Mr. Pratt, do you wish to say something?

Mr. E. W. Pratt: (C. & N. W. Ry.) I wanted to say right after the President's remarks that it was probably because he and the Secretary had not been to prayer meeting for so long they did not appreciate an experience meeting such as we have had to-night.

One of the speakers mentioned an engine at a lower steam pressure failing to maintain the efficiency of that pressure as uniformly as it would if it were carrying a higher maximum pressure. It oc-

curred to me at that time that when a boiler is not steaming, as sometimes happens from the front end devices being out of place, no leaks, just merely not steaming, we all know that the engine will drop back to a certain point which is the amount of steam that the boiler will make under those conditions and with the passage of the steam through the throttle. Therefore it seems to me that there is a lower pressure that every locomotive shows when it is not steaming freely, which indicates the point that has been proven by these experiments, and I just wanted to ask Prof. Goss, who is, I know, much better acquainted with the experiments that were made in England several years ago, eight or ten years ago, and determined, if I remember rightly, upon 160 pounds as the most efficient steam pressure for a single expansion locomotive.

Mr. W. G. Wallace: Mr. President, I have listened to the discussion of the paper with a great deal of interest, but I did not come prepared to enter the discussion, other than this: I have recently been connected with a railroad where we had consolidated locomotives with 22x28-inch cylinders. Some of those locomotives were carrying 160 pounds boiler pressure, others 180. The average tonnage up a two per cent grade was 460 tons. The locomotive carrying the 180 pounds pressure did not show any decided advantage over the locomotive carrying the 160 pounds pressure on that grade and in that service. It seems to me largely a question of design and pressure to meet the requirements and the conditions under which you are doing your work.

President Bentley: I don't quite follow your argument, Mr. Wallace. Do I understand you that the engines were identically the same in size and cylinder and weight, and yet they carried a difference in pressure of 160 to 180 pounds?

Mr. Wallace: Yes, sir, the difference in the amount of work those engines performed on that grade was not perceptible. The engine with lower pressure would take the train of 460 tons up the hill in as good time as the engine carrying the higher pressure. That was our experience.

President Bentley: Well, I could hardly realize it, and I don't think that Prof. Goss really thought that an engine carrying 160 pounds, as against 180 of the same size and dimensions, could do as good work as the engine carrying the 180 pounds pressure; at least I did not understand him to state that. Is there any other gentleman who would like to give us any information on this subject? If not, we will call on Prof. Goss to close.

Mr. Ira C. Hubbell (Locomotive Appliance Co.): Communicated—Mr. President and Gentlemen:—I consider the paper presented to this Club by Prof. Goss this evening as a very valuable addition to the intelligent researches in connection with the development of what is, to my mind, one of the greatest factors in the upbuilding of the industries of the world, namely, the locomotive.

Discussion of the paper appears impossible, except we may consider that the endorsement of the facts presented is "discussion." This paper does not present for the attention of the engineering and mechanical men a line of theoretical deductions but is a resume of facts developed at great expense and by a greater degree of individual sacrifices than the casual reader can possibly discern, and must therefore claim the earnest consideration of the man who thinks. The paper deals with and presents facts, and I have had pleasure in finding that theory leads to the facts deduced by the series of practical demonstration which made possible the presentation of the record to this meeting.

The office of a boiler is to supply energy to drive the engine. The demand on the boiler is the demand on and of the engine. The engines to develop the power must have area of pistons, travel of the pistons and pressure; therefore, we can reduce the demand of the engines on the boiler to a given number of pounds of water which must be evaporated per square foot of heating surface per hour.

For this purpose I have developed the following formula to facilitate analysis of locomotive performances, which I have frequent occasion to make, viz.:—

$$\frac{\text{Dia.Cyl.}^2 \times \text{Stroke} \times 2290 \times (\%\text{ of cut-off} + \%\text{ of Cyl. Clearance}) \times \text{Speed miles per hour}}{(\text{Dia. Driving Wheels} \times \text{Volume of Steam at guage pressure} \times \text{Sq. Ft. heating surface of Boiler})}$$

which gives the number of pounds of water at 39°F. (maximum density) which must be evaporated per square foot of heating surface of boiler at the pressure designated to supply the steam of that pressure to supply the cylinder volumes at the speed designated.

The constant 2290 is not exact? It should be 2288.9346. I use 2290 for convenience and because safe. The results obtained utterly disregard *all losses* of water, whether as water or as steam and whether from leakage of steam or from condensation; nevertheless the comparisons obtained are of value to determine quickly the relative efficiency of designs.

Now, let us apply the formula as above to three different specifications based upon the paper of the evening.

First. A locomotive carrying 200 lbs. gage pressure and which is the working pressure, cylinder 22"x30", driving wheels 57" over tires, total heating surface 2258 sq. ft., speed 30 miles per hour, working at 30 per cent cut-off and cylinder having 2½ per cent clearance; we have—

$22^2 \times 30 \times 2290 \times (.30+.025) \times (30) \div (133 \times 57 \times 2258) = 16.7$ lbs. water at 39° which must be evaporated per sq. ft. heating surface.

Second. Take a locomotive carrying 180 lbs. gage pressure, other specifications same as in the first instance except boiler is reduced in weight for reduced pressure and cylinders are 23"x30" to maintain practically same tractive power, and we have $23^2 \times 30 \times 2290 \times (.30+.025 \times 30) \div (145 \times 57 \times 2558) = 16.76$ lbs. of water at 39°F. to be evaporated.

Third. Let us now follow the deductions of Prof. Goss and design our boiler for 180 lbs. gage pressure, but make it a little larger so as to maintain same weight as in the first locomotive with an assumed addition of 5 per cent to the heating surface, cylinders 23x30, to maintain tractive power of 22″x30″ cylinders with 200 lbs. gage pressure, and we have—

$23^2 \times 30 \times 2290 \times (.30 + .025 \times 30) \div (145 \times 57 \times 2687) = 15.96$ lbs. of water at 39° F. to be evaporated.

In the specifications I have used for these comparisons it is proper to state that the boiler has been designed so as to provide very liberal space between tubes and sides to facilitate the circulation of the water, and therefore the total sq. ft. of heating surface seems somewhat reduced, but the practical results had from the boiler in daily service has justified the apparent sacrifice of tube surface. The boiler is 74″ dia. with 308 2″ tubes.

I was not able to present this analysis at the meeting for lack of time to read the paper in full prior to the meeting; however, trust that the figures will interest our members and serve the writer's desire to heartily support and endorse the generosity of Prof. Goss and his associates in giving to the Club and to me personally such valuable information as I have derived from their unselfish labor.

PROF. GOSS: Mr. President, I will be very brief in closing, only attempting to cover in a general way the points which have been raised.

First as to the side sheets. The side sheets of Schenectady No. 1 and the side sheets of Schenectady No. 2 were both of steel and of the same thickness. I do not know whether they were of the same composition or not. Moreover, the failure after 30,000 miles would not, I suppose, have been regarded an absolute failure on the road. Incipient cracks appeared which led to trouble in keeping the boiler tight.

There is nothing in my paper which concerns existing engines. I think, as the President has said, that one should go slowly in reducing pressure on existing engines unless the cylinders are enlarged, though I admit that it may occasionally be done with good results. The whole problem is one of design.

My paper presents no argument in favor of increasing weights either of boilers or of the locomotives as a whole. These are questions which are entirely apart from my discussion. My whole purpose has been to show how best to utilize whatever weight may be allowed. Assuming, for example, that the general design of a locomotive has been so fixed that 35,000 pounds may be allowed for the weight of the boiler, and that the designer must choose the pressure before he proceeds with his work. With the limit of weight defined, if he chooses 210 pounds, the extent of heating surface must necessarily be less than if he chooses 180 pounds. The conclusion derived from my investigation is to the effect that for the develop-

ment of a given power, the locomotive will be most economical when supplied with the larger boiler designed for the lower pressure. It is in this sense only that my paper argues in favor of "larger boilers."

There is nothing in my paper which points to a reduction of power in locomotives. When the steam pressure has been fixed, the output of power depends upon cylinder proportions and upon the degree of efficiency which attends their use of steam. It is assumed that as pressure is reduced, cylinder volumes will be increased. With this understanding of the matter, my contention, based upon experimental data, is to the effect that for highest economy, the pressure upon a single-expansion locomotive should ordinarily not exceed 180 pounds, because under this pressure such a locomotive will develop a given power more economically than if designed for any other pressure. Stating the same fact in different terms such a locomotive, because of its superior economy under a pressure of 180 pounds, may be made to develop more power than a single-expansion locomotive of the same weight, when designed for any other pressure.

Finally, in this connection, due emphasis should be given the fact that the selection of 160 to 180 pounds as the running pressure of a locomotive, is not to be regarded as a backward step. The problem is to increase the efficiency and power of locomotives and if it is shown that a reduction of pressure is a means to such an end, real progress is to be achieved by reducing pressure.

I regret that my paper as presented, does not include the proof of some of my statements. This will be found in the publication which is soon to appear.

The discussion has raised the question as to the steam pressures in compound service, and mention has been made of the good results which follow compound engines using high steam pressure. I assume that it is understood that my paper simply concerns the single expansion engine; that the problem of the compound has not been considered. I also call attention to the fact that as a matter of simple theory we all know that the compound engine can properly utilize a higher pressure than can a simple engine, so that we should expect that a compound engine will do well under higher steam pressures than are desirable for a simple engine.

Now there is a matter of history that it is fair that I give you. Ten years ago the Master Mechanics' Association had a committee on high steam pressures, a preliminary report having been rendered in 1898. That report gave results derived from a locomotive limited in pressure to 140 pounds. But it outlined a procedure which was later followed in securing the data which underlie the conclusions of the present paper. The point I would emphasize is that the problem to which I now bring you the solution was outlined and the outline was published in 1898. At about this time

also Purdue University supplied itself with a locomotive having a very strong boiler for high pressures, and it was expected at that time that in a year or two data of value would be available. But nine years have elapsed since the plan was perfected, and the apparatus necessary to its execution supplied, and it is only now that we have been able to speak with certainty. These results might have been available long ago if the Purdue laboratory had only had a little more money which could have been put into operating expenses. The absence of special aid has required all work at the plant to be secondary to the instruction of students and research has proceeded slowly. It was only after the Carnegie Institution came forward two years ago with a considerable grant of money that the work long ago planned could be brought to a satisfactory conclusion.

Now what is being done in connection with the single expansion locomotive ought to be repeated in all of its details, first, with reference to the superheating single expansion locomotive and afterwards with reference to the compound locomotive. I am hoping that some way will open by which the activities of the laboratory will be greatly increased, in order that we may not need to wait ten years more before results can be had which will be of service in fixing practices with reference to these two important subjects (applause).

Mr. Hubbell: I move a rising vote of thanks to Prof. Goss for the very instructive paper that he has presented to our Club.

President Bentley: Before that is done, gentlemen, I want to ask Prof. Goss a question, please. The suggestion that you have made, Professor, that the subject of investigation of engines equipped with superheaters and engines equipped with compound cylinders be given consideration, is something that I think the Master Mechanics' Association ought to take up, with a view to seeing whether the necessary funds could be raised for that purpose; and I would like to know, if it is not asking a question that is irrelevant, what the approximate cost would be for the carrying on of those experiments.

Prof. Goss: For the research which I have repeated to you we have had the sum of $5,000 from the Carnegie Institution. Ten or twelve thousand dollars supplementing the University funds would probably serve for both of the researches I have outlined.

President Bentley: You have heard Mr. Hubbell's proposition to give a rising vote of thanks to Prof. Goss for his very excellent effort to-night. All in favor will rise.

The motion was carried unanimously.

President Bentley: Prof. Goss, we thank you very much for the entertainment of this evening.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, December 18th, 1906. First Vice-President C. A. Seley in the chair.

The meeting was called to order by the Chairman at 8. P. M.

Among those present the following registered:

Allison, W. L.
Ames, C. F.
Anderson, David
Baker, F. L.
Beland, Geo.
Benedict, B. W.
Bond, J. E.
Bower, J. G.
Brown, S. D.
Benjamin, F. G.
Burnett, R. W.
Callahan, J. P.
Cardwell, J. R.
Carlton, L. M.
Carney, J. A.
Collier, F. P.
Cory, C. H.
Cunningham, A. J.
Dailey, G. W.
Darby, I. W.
Davis, J. L.
DeRemer, W. L.
Dewey, L. R.
Doud, Willard
Edwards, F. W.
Endsley, L. E.
Ernst, Fritz
Estrup, H. H.
Feldhake, J. M.
Fenn, F. D.
Fitzmorris, Jas.
Flavin, J. F.
Fogg, J. W.
Forsyth, Wm.
Furry, F. W.
Goodnow, T. H.
Goodwin, G. S.
Groce, G H.
Haig, M. H.
Hammond, W. S., Jr.
Harkness, J. L.
Henderson, T. D.
Hinds, J. B. L.
Hopkins, G. H.
Hungerford, L. S., Jr.
Jeffries, B. H.
Jenks, C. D.
Jett, B. E.
Jones, L. E.
Kahler, C. F.
King, C. H.
Kucher, T. N.
Lancaster, J. R.
LaRue, H.
Layng, J. F.
Lewis, J. H.
Linn, H. R.
Little, J. C.
McAlpine, A. R.
McLelland, H. B.
Mackie, J. F.
Millspaugh, C. W.
Meeder, Harvey
Meeder, W. R.
Molleson, Geo.
Monroe, M. S.
Munger, E. T.
Neff, J. P.
Olk, C. J.
Osmer, J. E.
Otis, Spencer
Otley, Benj. F.
Ott, O. W.
Otto, Oscar
Peck, Peter H.
Phillips, L. R.
Pratt, E. W.
Ramey, E. E.
Reilly, T. S.
Richardson, G. A.
Royal, Geo.
Rutherford, E. C.
Seley, C. A.
Sharp, W. E.
Sipp, B. F.
Slater, F.
Smith, R. D.
Smith, M. N.
Smith, W. R.
Squire, W. C.

State, R. E.	Templeton, W. B.	Walbank, R. T.
Stocks, W. H.	Thomas, A. R.	Wallace, W. G.
Studer, F.	Thompson, E. B.	Webb, E. R.
Symons, W. E.	Thompson, J. R.	White, Wm.
Talbott, Chas.	Thurnauer, Gustav	Williams, M. E.
Tawse, W. G.	Tinker, J. H.	Wright, Wm.
Taylor, J. W.	Wade, E. H.	Young, C. B.

THE CHAIRMAN: The first order of business will be the approval of the minutes of the last meeting. They have been printed and distributed, and unless objection is made, they are approved.

The Secretary will read the membership report.

THE SECRETARY: Mr. Chairman, I have the membership list as follows:

Membership, November, 1906		1,311
Dead	1	
Resigned	0	
Non-payment of dues	9	10
		1,301
New members approved by Board of Directors		24
		1,325

C. F. Elliott, Acme White Lead & Color Wks., Detroit, Mich.	G. H. Bryant
E. M. Hall, Atlantic Equipment Co., Chicago, Ill.	J. H. Wynne
F. J. Ryan, McGuire-Cummings Mfg. Co., Chicago, Ill.	J. W. Taylor
E. M. Kerwin, McGuire-Cummings Mfg. Co., Chicago, Ill.	J. W. Taylor
J. R. Van Cleve, M. M. Alaska Central Ry., Seward, Alaska	J. W. Taylor
R. W. Burnett, Chicago, Ill.	W. E. Sharp
Morris Moskowitz, Engr. Commercial Acetyline Co., Chicago	E. N. Hurley
C. M. Anderson, Special App. C., B. & Q. Ry., W. Burlington, Ia.	J. G. Crawford
L. W. Wilson, Special App., C., B. & Q. Ry., W. Burlington, Ia.	J. G. Crawford
J. E. Gardner, Special App., C., B. & Q. Ry., Aurora, Ill.	J. G. Crawford
E. M. Switzer, Jr., Special App., C., B. & Q. Ry„ Aurora, Ill.	
R. Sturgis, Special App., C. B. & Q. Ry., Aurora, Ill.	J. G. Crawford
G. C. Bingham, Mach. Foreman, C. & N. W. Ry., Winona, Minn.	J. G. Crawford Chas. Coleman
J. Z. Murphy, Engr., Chgo. Union Tract. Co., Chicago, Ill.	Jas. Lyman
H. B. Fleming, C. E., Chgo. City Ry. Co., Chicago, Ill.	Jas. Lyman
W. H. Dangel, Lovejoy Tool Wks., Chicago, Ill.	H. T. Bentley
C. R. Allison, Draftsman, C., H. & D. Ry., Lima, Ohio	C. H. Cory
J. F. Mackie, Secy.-Treas. & Ed., T. D. A. of A., Chicago, Ill.	B. F. Sipp
Albert Ossberg, M. E., Armour Car Line, Chicago, Ill.	W. E. Sharp
David Anderson, M. M., Chgo. Union Tract. Co., Clearing, Ill.	C. F. Ames
H. H. Estrup, Car Fore., C. & E. I. Ry., Chicago	W. G. Tawse
W. W. Ricker, Niles-Bement-Pond Co., Chicago	C. A. Siley
W. R. Smith, Fore., C. & N. W. Co., Chicago	W. H. Bradley
H. Meeder, R. H. F., C. & E. I. Ry., Chicago	W. R. Meeder

DEAD

G. B. Nicholson, C. E., C. N. O. & T. P. Ry., Cincinnati, Ohio.

RESIGNED

E. J. Gavney, Engr., C., B. & Q. Ry., Burlington, Ia.

DROPPED—NON-PAYMENT OF DUES

F. H. Dersh, F. M. S., C., M. & St. P. Ry., Dubuque, Ia.
E. J. Campbell, G. F., C. T. T. Ry., Hammond.
D. C. Courtney, Allegheny, Pa.
G. W. Beebe, F. C. R., C., B. & Q. Ry., Aurora, Ill.
T. R. Browne, Amer. Car & Fdy. Co., New York.
A. E. Benson, Foreman, C., B. & Q. Ry., E. St. Louis, Ill.
W. S. Blennerhassett, T. F., St. L. & S. F. R. R., Monett, Mo.
C. T. Boone, Trav. T. M., C. & N. W. Ry., Chicago.
J. J. Brady, Draftsman, N. Y. C. & H. R. R. R., W. Albany, N. Y.

THE CHAIRMAN: The first paper for discussion this evening is entitled "The Train Dispatcher," by Mr. John F. Mackie, Secretary of the Train Dispatcher' Association. I take great pleasure in introducing Mr. Mackie and would ask that he come to the front and read his paper.

MR. J. F. MACKIE (Sec'y T. D. A.): Mr. Chairman and Gentlemen of the Club: I confess to a feeling of diffidence in appearing before a body of, I may say, such distinguished gentlemen as those who are members of this Club. When my friend, Mr. Sipp, spoke to me some weeks ago in regard to the preparation of a paper to be read at this meeting, I felt a good deal as the boy must have done who was asked by his teacher to write an essay on "Man." The paper read somewhat like this: "Man, like all Gaul, is divided into three parts, the occiput, the borax and the abominable cavity. The occiput contains the brains—when there are any; the borax contains the heart and the lungs and part of the liver, while the abominable cavity contains the bowels of which there are five, a, e, i, o, and u." I was afraid I might turn out something like that, and I hope you will pardon any imperfections you may find in my paper, which has been prepared with the object of bringing before this Club and through its instrumentality, before the railway world, the position and the responsibilities of the Train Dispatcher, who fills such a very important function in railway service and in regard to whose duties and responsibilities and place in the service I have some ideas which I am glad on this occasion to be able to ventilate. With these preliminary words, I will proceed to read the paper.

THE TRAIN DISPATCHER.

John F. Mackie, Secretary and Editor T. D. A. of A.

When, in the coure of human events, the railway sprang into being on this continent, it became apparent that the conditions to which it must conform were so different from those existing in Europe that the analogies of operation there were of little value here. These railways had been built to serve a commerce already existing and

which offered immediate and sufficient remuneration from the outset for double track lines, while in the United States and Canada, with their vast distances and sparse population, the success of even a single track line of any considerable length was problematical. To afford even the remotest prospect of successful results it was necessary that the operating staff must be limited to the indispensable, and methods followed that would give the maximum of operating efficiency with the minimum of staff. Out of these conditions the train dispatcher was evolved and it will be the purpose of this paper to show how efficiently he has performed his allotted function and how necessary he has proved himself to successful railway operation on this continent. Elsewhere he is practically unknown. I venture to say that nowhere else, did he exist, would the importance of the duty he performs be so lightly regarded and nowhere else could the burdens imposed upon him be so successfully borne by the individual.

Very early in the history of American railways the telegraph became an important adjunct to operation. The time-table, of course, prescribed the general law of train movement, but the time-table could not provide for delayed trains without exasperating and expensive disturbance to the movement of traffic. The telegraph made the train dispatcher possible. The shortcomings of the time-table made him indispensable. It was (and it remains) his duty to co-ordinate the movement of the train units in his charge so as produce the maximum of transportation efficiency possible under any conditions that may arise. When trains are on time the time-table usually suffices, but there are many times-tables under which regular meeting points must be daily remade by train order. And all trains are never on time, so that the dispatcher must improvise a new time-table every day and every hour of the day under conditions that vary from hour to hour and are never the same. He must do this often with the aid of indifferent, sometimes almost incompetent operators, with inadequate sidings which necessitate sawing by and under a mental strain and a direct personal responsibility for the safety of life and property such as is borne by no other railway officer. This is the daily task of the train dispatcher. That it is no easy one, and that it necessitates to the highest degree, coolness of brain, alertness of intelligence, excellence of judgment and swiftness of decision must be apparent. It is no wonder that the discipline of such a training has evolved such men as W. C. Brown of the New York Central; F. D. Underwood and J. C. Stuart, of the Erie; G. W. Stevens, of the Chesapeake & Ohio; Marvin Hughitt and W. A. Gardner, of the Chicago & North Western; I. G. Rawn, of the Illinois Central; W. A. Garrett, of the Seaboard Air Line; W. J. Murphy, of the Queen & Crescent, and innumerable other distinguished railway officers whom I might name did time permit. It will be no wonder if, from the ranks of the train dispatchers of today shall rise men no less great.

Yet, strange as the statement may seem, this position of train dispatcher (which might with truth be better called "Director of trains"), weighted, as it is, with tremendous responsibility, demanding, as it does, the highest qualities of mental fibre, involving, as it does, duties inherently directive and absolutely indispensable to good service, is apparently so little thought of by many railway managements that hundreds of train dispatchers in the service are today doubtful whether they can be regarded as officials at all, and they have some excuse for the doubt in the slight consideration accorded them, which is less, in some cases, than is given many of the men subject to their orders. I have in mind one line and such lines have been more numerous in the past than now, whose rules expressly provide that as between train dispatchers and conductors and engine men, no superiority could be considered to exist. And this in the face of the fact that the train dispatcher on duty is within his sphere invested with all the authority of the superintendent, in the majority of cases uses his initials without any qualifying "per," and is expected in emergency to use the authority attaching to the office, which all men affected must obey. Words fail me in the endeavor to fitly characterize plain idiocy like this. Such a state of things is not conducive to good service. It is not healthful. And it ought to be set right, if such managements care to retain the loyalty of their train dispatchers to the service, a loyalty which ought to be and never ought to be other than superior to any obligation which could or might make it secondary, but which cannot be expected to thrive under the smart of a sense of depreciation. Frank recognition of the official status of dispatchers in deed as well as in word is certainly desirable; to my mind, it is imperatively necessary to the forestalling of disloyal combination. Devotion to the interests of the service, a devotion superior to any other consideration, is the recognized duty of every official, whatever his rank. Treat a subordinate officer as if he were not one, and you go far toward stifling in him that feeling of responsibility for the good of the service, in the general sense of the phrase, that characterizes the official as distinguished from the employee.

Entering railway service as a telegraph operator forty-eight years ago, when the train dispatcher, where he then existed, was the first lieutenant of the superintendent with no intervening officer. I have observed with interest and some apprehension, with many doubts of its propriety, and latterly, with a firm conviction that it is a grave error of organization, the rise of the train master to be the superior in rank of the chief dispatcher. The duties of the latter officer are of such importance in the handling of transportation that, to my mind, the intervention of any authority between him and the superintendent is something which ought not to be permitted. The trainmaster is necessarily charged with the supervision of trainmen and in the discharge of his duties must be out on the road the

greater part of the time. Necessarily he knows less of general conditions than does the chief dispatcher. He sees what is going on under his eye and can only guess in a general way what is being done on the entire division, while the chief dispatcher, located at the center of things, is conversant with all, and must act, in the great majority of cases, upon his own responsibility and his own initiative. To him as an officer should belong the credit of duty well done and upon him should rest the responsibility of mistakes. Often the trainmaster has risen from a branch of the service which habitually belittles the train dispatcher, which, seeing only the movement of one train necessarily held back and not understanding the situation of all trains, mentally, if not openly, damns the dispatcher on duty as incompetent and in many cases would be able to recognize good train dispatching only after a laborious explanation or not at all. Often the fact that the trainmaster disapproves of something done, which the chief dispatcher knows was unavoidable when it was done, prevents the superintendent from knowing the truth of the matter, since to explain directly to him, in common phrase "to go over his head," would, in the view of the trainmaster, be rank insubordination. The resultant friction is an unquestionable injury to the service. The chief dispatcher should, to my thinking, be entirely free at all times to go without fear of misunderstanding to his superintendent. Often, when this is desirable, the chief dispatcher hesitates to do it, apprehensive of how the trainmaster might take it and, anxious to maintain harmony, he submits to disparagement of his department as the least of two evils. More than one case has come to my knowledge where chief or trick dispatchers, anxious to do their duty and ably performing it, to the benefit of the company, have been obliged to resign because they preferred that to taking issue with a trainmaster whose tendency it was to charge shortcomings in train movement to "poor dispatching," when the real trouble was beyond the control of the most competent dispatcher or chief. This condition of things ought not to exist and would not be likely to exist were the chief dispatcher an officer co-ordinately with the trainmaster, both directly subordinate to the superintendent and neither superior to the other. But this, as railways are usually organized, is not the case, although the position of the chief dispatcher and the good of the service would amply warrant it. The example of the Burlington Lines, whose train dispatchers have made their mark on the railway world to an unusual degree and which has followed this plan of organization for lo, these many years, testifies to its wisdom and the excellence of its results in harmony of operation, and upon the dispatchers in whom it stimulates legitimate ambition and to whom it affords an incentive to qualify themselves for the higher duties to which they may aspire and to whose opportunities they may reasonably look forward when the fullness of time arrives.

There has grown up, of late years, a tendency to belittle the work of the train dispatcher and to compare it unfavorably with that of his predecessors in this branch of the service. The American system of train dispatching and the men who conduct it are equally disparaged. All of us can appreciate today the superiority of the staff and the block over the train order system in point of safety and general desirability, but it is impossible to dispute the superior economy of the latter, more especially in the early days when the roads upon which these superior safeguards are now possible, were struggling for existence, earning barely enough to meet operating expenses, living from hand to mouth, as it were, supplying the public need of transportation as well as their limited facilities and scanty resources would permit, and enabled to do much with little, largely because the train dispatcher was there to guide and direct train movement and, with a telegraph wire, a few telegraph operators and the co-operation of a generation of trainmen in whom necessity had bred and encouraged intelligence and initiative, made human brains supply the lack of mechanisms and, with a pay roll pared to the bone, produce unparalleled efficiency. Yet the usefulness, nay, the necessity for the train dispatcher has not ceased or diminished with the ending of the period in which he began. When one considers what the train dispatcher really is, aside from the methods used by him which are truly but evanescent, the importance of the function he performs, the necessity of such a functionary becomes increasingly evident. It is by no accident that the advent of double, triple and quadruple track railway systems, the inauguration of telegraph, manual controlled, and automatic block systems; the movement of trains by signals instead of train orders and time-table classifications of train superiorities; and the other advances in safety and celerity of train movement that are being made—it is by no accident, I say—that the train dispatcher, where these improvements are in effect, remains in office and is still an indispensable officer. He continues and will continue to be the man who harmonizes and co-ordinates conflicting superiorities or degrees of train importance, so as to minimize delays, provide for the removal or surmounting of obstructions to free train movement and to unite into the grasp of one hand and under the guidance of one intelligent brain the shuttles of the great web of commerce that is being woven and that grows from year to year in increasing volume upon the rails of this continent of ours. Truly it is a great and wonderful task that is performed by the train dispatcher. Rightly is he invested with all the authority of the superintendent in the performance of it. Patiiently, faithfully, watchfully, efficiently he sits in his chair of office for eight or twelve strenuous hours daily as the shuttles of traffic move under his guidance, in unceasing and orderly sequence.

One might naturally infer from this not overdrawn picture that the man who does all this, whose transcendently important duties are what I have described, would be jealously guarded from intrusion, the logical sequence of his thought left undisturbed by other less important matters, and all the energies of his being isolated from all considerations other than such as pertain to his duties; but this would be a mistake. It is not infrequently the case that the dispatcher's office is open to all with whom his work brings him in contact. The train conductor may interrupt him in the midst of the most complicated situation and require his immediate attention —through a wicket, of course—but none the less imperatively. The trainmaster or chief dispatcher (trainmasters and chief dispatchers are not always wise) may break into his work with verbal instructions as to some detail or other, relatively insignificant, which, if overlooked, will subject him to severe criticism. The omnipresent and insistent telephone may—I speak more particularly of night dispatchers on solitary duty acting, for the time being, as superintendent, trainmaster and chief dispatcher rolled into one—the telephone may disturb his most careful calculations at any moment and compel a duplication of mental processes not safely to be meddled with, yet, on the whole, he emerges successfully from the wrestle with time and circumstance which forms his daily task, not without credit, yet, often, when he does his best, with less credit than is his due. That, however, is one of the inevitable accompaniments of such duties as his, which necessitate forecast of an undeveloped situation whose development can only be guessed at and is governed by circumstances over which the guesser has only partial control, but which, as it develops, makes out a case of defective judgment against the unfortunate guesser, the dispatcher. The temptation to criticise is almost irresistible to the man enlightened by afterknowledge of the circumstances, who is unable to put himself in the place of the man compelled to guess beforehand and to estimate, weigh and balance probabilities, and who must decide and decide promptly in many cases without sufficient time to properly do it, which of three or four possible things is the more likely to occur. And I must linger for a little at this point to consider briefly why such errors of judgment occur in these strenuous days more frequently than was once the case. That this is so no one can deny. That dispatchers of the present day are stigmatized as of inferior calibre to the men who preceded them is a fact. That they, taken by and large, deserve this censure is difficult to disprove. Yet I believe it to be capable of disproof. When one compares the difficulties to be contended with now, with those of the dispatchers of the past generation, or even of ten years ago, one thing stands out clearly, viz.: that with the enormous increase in traffic of late years, there has been no commensurate increase in the train dispatching staff. Districts operated by three men and a

chief ten or twelve years ago, and upon which traffic has doubled or grown in even greater ratio, are still often manned by three men and a chief, with possibly a night chief to partially relieve the strain. The length and tonnage of trains has so increased that each unit has become much more unwieldy and much more difficult to handle. Sidings once amply adequate for two trains will now barely hold one, and while there has been some increase in such facilities, it has often failed to keep pace with requirements. Under such circumstances the train dispatcher, simply because there are but 480 minutes in eight hours, has been largely deprived of the opportunity to exercise the forethought necessary (in *his* case beyond almost any other), and his work suffers to a degree that operates injuriously to the service. Often he has not time to think out carefully the things he must do. Naturally his combinations are sometimes imperfect. Yet there are men equal to the increased strain. In spite of all difficulties they are able to conquer the situation. And because there are such men—amazingly numerous, on the whole—officers, many of them former dispatchers, are prone to consider the others incompetent, when in fact they are simply average dispatchers and their critics have forgotten that the work demanded of the average dispatcher has become more and more difficult with the years and now in many cases exceeds the capacity of average ability. Only unusual ability can meet the requirements of the situation, yet it is frequently rated as the standard to which average ability is expected to rise. This, in my judgment, it is not reasonable to expect or require. In any large class of men the average requirement should not be expected to exceed average capacity. There were indifferently equipped dispatchers in the past as there are now. But they were not competent—beyond the average capacity—any more then than now. Only, less was expected of them then. Train dispatching can be done by but one man on any given district and no other man can do it for him, or assist him in the doing of it, beyond relieving his fingers of some of the drudgery of the telegraph key. Consequently the only remedy for overloading him beyond average ability is to shorten districts or else to make the position more desirable to superior ability both in point of dignity and of remuneration. I hold it to be a grave error of administration to economize in train dispatching force. What is saved in the train dispatchers pay roll is often lost five or ten fold in increased operating cost.

It should be understood that in all I have said, there is no desire to indulge in strictures upon railway officers or managements beyond what seems to me necessary to call attention to things detrimental to the service which deserve, and at this particular time, demand, consideration. Recently there has arisen an organization of train dispatchers, modeled after the usual union pattern, which is actively soliciting adherents among the train dispatchers of all lines on the continent. Whatever may be the case with trainmen, telegraph

operators and other unionized classes of railway employes—and I have no desire to discuss that question here—a trades union of train dispatchers seems to me a distinct peril to the railway service, a thing which cannot co-exist with efficient administration. That it has some cause for being inevitably follows from its actual existence, for there is no effect without cause. In my humble opinion, some of the causes lie in the facts I have tried to point out and chiefly the fact that the train dispatcher has been—whether inadvertently or deliberately does not alter the fact—kept on the fence, as it were, between official and employee. To my thinking he is an official beyond any doubt, charged with great directive responsibility; the fingers, if I may so speak, of the administrative hand, with which it grasps and guides train movement, that which is the vital life blood of the entire organism; a function always tacitly recognized as official yet often practically ignored and minimized into an insignificance which makes its duties unrecognizable as officialism to hundreds of those charged with its tremendous responsibilities, yet also fully recognized by other hundreds, of whom I am representative, who understand the essential character of their duties as members of the directive arm of the service and who perform those duties with loyalty and such ability as they severally possess, who face their responsibilities with cheerfulness and courage and to whom the good of the service, through their instrumentality, is chief of all things to be considered, striven for and achieved.

THE CHAIRMAN: The valuable paper which Mr. Mackie has favored us with, presents a phase in railroad evolution that is very interesting. It treats of a class of employes whose duties are most onerous, who have to assume much responsibility and their case is clearly and strongly pleaded. Now that railroads are measured by the thousands of miles instead of by hundreds as formerly, the administration of transportation orders and movements has increased in importance far beyond the ratio of increase of mileage and it seems wise to consider if the old line of organization can be expanded to meet present requirements, or is something more required. Mr. Mackie has raised the question and stated his position and the matter is now open to the floor for discussion. There are I believe a number of Superintendents of Telegraph and other officers of the transportation department of railways who have been specially invited to hear this paper and participate in this question. I desire a motion granting the privilege of the floor to any railroad officer not a member of the Club desiring to speak on matters touched upon in this paper.

MR. J. A. CARNEY (C. B. & Q.): I make a motion to that effect, Mr. Chairman.

Motion duly seconded and carried.

THE CHAIRMAN: This is a live subject, gentlemen, and I would like to have some one start the ball rolling. Mr. Sipp, will you open the discussion?

MR. B. F. SIPP: Mr. Chairman, I had understood that there were to be some Superintendents of Telegraph and some other transportation men here tonight to talk on dispatching, and that we will hear from them. I feel that Mr. Mackie has given us a very valuable paper and an exhaustive one, from his point of view. The Train Dispatcher is an important official on our railway lines; he holds a position by virtue of which during the day and night when trains are moving over the road he is required to meet and pass those trains so as to keep them as near schedule as possible. He is required to handle all wrecks that occur, in addition to the dispatching of trains; he is also the car distributor, telegraph operator, and he is burdened with a great many duties as an operating man. Mr. Mackie has dwelt upon the points so fully that I cannot add very much to them. I suggested the advisability of Mr. Mackie presenting this paper to the Club, and feeling that it would be of interest to the members.

THE CHAIRMAN: Mr. Daily, of the North-Western, may we hear from you?

MR. G. W. DAILY (C. & N. W. RY): Mr. Chairman and Gentlemen. Not having seen this paper until this evening, I do not feel that I have given it sufficient thought to make any remarks on it. I do not know that I should say anything but having shared the joys, the pleasures, the treats and tribulations of the Train Dispatcher, I merely wish to back up Mr. Mackie to a certain extent and say that I consider the Dispatcher one of the loyal, conscientious, hard working, reliable employes of the railway. He is one of the men behind the gun, one of the men that make the wheels go around, one of the men that make or break a division. He comes in very handy at times to censure when something goes wrong, when some mix-up occurs, when some immediate superior does not want to assume responsibility. He nearly always gets all the blame he deserves and a little more, and does not always receive his share of the compliments and commendations which well-pleased general officers sometimes give to successful superintendents; in other words, someone occasionally steals his thunder when it sounds good. The fact was brought out by Mr. Mackie that sometimes he is not appreciated and recognized to the fullest extent. I think that true to a certain extent. The reason probably is that in the rapid age in which we are living when you have to be a mental acrobat and a lightning thought artist, people do not have very much time to indulge in compliments; possibly they do not do it enough; they do not have much time to think of anything except forcing their business along, keeping out of trouble, and showing a clean pair of heels around the track. We have to trot fast or get run over these days.

Personally, I think that the Train Dispatcher is a very responsible individual, possibly more so than we often stop to realize.

His responsibilities are many and varied and these responsbilites have been very clearly stated by Mr. Mackie. I notice in one part of Mr. Mackie's paper that he speaks of the incompetency of operators. That brings to my mind the thought that the train dispatcher's responsibility extends that far also, and isn't he responsible to a certain extent for that incompetency? I will say that one of his greatest responsibilities is the handling of the personnel in order to obtain the maximum of efficiency or results. Ordinarily a busy Train Dispatcher does not have much time to devote to the matter of educating or drilling telegraphers on his division in their duties, but when we stop to think a moment, the Dispatcher is about the only officer we have who can educate or train them, mould them, as it were. He is the man who deals directly with them, that works constantly with them at first hand. The employes of the division to a certain extent look to the Dispatcher's office for guidance, and they largely follow the practice, the method, the example, I intended to say, that they see set forth from that office.

I think a great many of the gentlemen here who have had divisional experience will agree with me that the train dispatchers and I may say the other division officers also, do not know their telegraphers as well as they might. This enters into the total result. There is good reason for it. It is easy to meet trainmen, it is easy to meet engine men by riding on the trains and meeting them at terminals, one end or the other of the division, and becoming acquainted, but the operator and the agent are isolated, scattered over territory six or eight miles apart, and in case of the average operator it is hard to see him. It is hard for a division officer to visit him; it may be inconvenient. A man may not have time to visit the day operator or agent as much as he should and may never see the night operator at all. The train dispatcher, and especially the trick dispatcher, being the man that deals directly with those men, working directly with them, I mean by that over the wire, is probably in the best position to develop, encourage and mould them; better than any man on the division. It seems to me that if train dispatchers generally would make it more of a point to go out over the divisions and get acquainted with those men, size up the individual, know what kind of a man he is working with, know what he looks like and what his name is, know what he is worth, that it would probably help the train dispatchers also. A train dispatcher may have a profound knowledge of rules and regulations, correct methods and correct practice, but if he does not have good facilities and good men to work with, it nullifies his efforts to a certain extent. One way to have good men is to encourage them, help them to advance and develop.

There is another matter comes to my mind, confirmed by my experience of the last few years in dealing with an organization of

telegraphers, that a great many cases of what we would call personal grievances emanate from some act of the individual trick dispatcher, with the individual operator or the individual trainmen or engineer. Most of us who have been train dispatchers, (and I notice several of my friends here who have been in active service on a division) know how they arise; they arise easily. Those quarrels and squabbles are things that a dispatcher should be careful to eliminate, to cut out. The way a dispatcher handles his division, and particularly the men on the division bears directly and greatly upon the result that he produces. The good train dispatcher is not always a man that is thoroughly well posted on rules alone; he has to know them well of course, he has to think and act correctly and carefully, but he does not have to be a scholar on rules; he does have to be a scholar on handling employes. I may be getting a little too deep into this subject, but I got started on this train of thought and might as well ride until it stops. It seems to me that outside of and beyond the matters mentioned by Mr. Mackie, this matter of handling the personnel is really one of the foundation stones of a successful train dispatcher, a successful division superintendent, or a successful railroad man, for that matter. It is the man that produces the goods, and if the man is not trained, is not educated up to the point where the good train dispatcher can avail himself of the maximum efficiency of the man, no matter whether he be an operator or an engineer, or a conductor, if he does not know how to get these men's best effort, he does not get the best result. The point in that connection is this,—willing service is the best service. You can get service for pay alone, but that is not the best service, and the only way to get willing service is to handle the employe, individually and collectively, in a manner that he will feel that he owes willing service to you and feels that he is justified in giving his very best efforts, no matter what his compensation may be. This can only be brought out by correct treatment, and by inspiring them with a feeling of confidence in your justice and your integrity. I think it is a man's natural inclination, of nine men out of ten at least, to do right, to do his best; he wants to do that if he can, or knows how. Fear of the ridicule of his fellows, or self-pride, will make him do so if nothing else. The officer should encourage and develop that inherent feeling through constant education, and personal influence and example. But he must be in a position to meet, study, and know the men under him before he can do it.

I notice another point in Mr. Mackie's paper where he mentions the lack of interest shown in the train dispatcher, or lack of appreciation; that is a matter that enters into the total result. You cannot always find it convenient, and perhaps it is not wise, to carry out to too great an extent the matter of commending a man; too much of it might spoil the making of a good man, or inflate the

self-estimation of a poor one. Then again there are usually more causes to indulge in profanity than compliments. However, I sometimes think we do not do enough of it. I presume that we are all railroad men here and probably realize that at times in our careers we have felt that we had done something exceptionally good, or above the ordinary; that our superiors should have noticed it, and that we would like somebody to tell us at least that it was appreciated. That is human nature. Still we can't expect them to be doing it all the time and there are so many good things done every day it would keep ten men busy telling us about it. We are always sure to hear from it if something goes wrong, you can bet on that, and its all right, but if some fellow does something exceptionally good, you don't always hear of it, which may be all right too. The point I want to make is this: I think a little commendation, a little praise, if you wish to call it so, at times is a pretty good investment if judiciously placed, and if some of the train dispatchers would indulge in that a little bit more than they indulge in the fire and brimstone they shoot over the wire, they would probably get better results and better results usually means better compensation. I have seen train dispatchers after having some difficulty and delay in raising an operator, waste three minutes in telling the man what he thought of him and would spend about thirty seconds in giving him the business or information he had for him. That is no way to get results. The way to get good results from a man is to give him first what business you have for him, and then, if you have any time left, tell him what you think of him. Just reverse it.

Another point: There are two or three things that are the bane of the division officer's life, and one of the particular things—I am saying this for the benefit of one of my friends back here—is the matter of engine failures, and most of the others are all summed up and laid up to poor dispatching, poor meeting points, and the dispatcher enters into them all, although not always to blame. We started on the matter of train dispatching, but I think I have wandered away from that point. I thought I would merely mention the matter of getting best results in dispatching by training, developing and encouraging the men, which might have a tendency to increase the importance of the position. I feel that no matter how much the dispatcher may know about his business, and how good the motive power may be, or the wires may be, unless the man, individually, is good he does not get full measure of results.

Another point that comes to my mind along this line is that when the dispatcher (and I am selecting him as the teacher in this case, because he really is the only man on the division that can educate and develop the telegraphers, because he is in the best position to do it), when the dispatcher trains and develops his employes, the result of his work extends on into the future, and the far-reaching effect

of that training is this: Usually the operator in time will become something better, he may become an agent, a commercial representative at some important place, he may go higher, he may become one of the leading men in the railway world. Mr. Mackie has mentioned some of those who have gone up this way, there are none better and I doubt if there ever will be. A great percentage of officers have graduated from telegraphy, and when the dispatcher spends his time developing, educating and moulding these telegraphers, he is not only helping himself, his position and his division by getting the maximum efficiency of the men, but the result of his work extends on over into the future, endures after him and lives when he is gone. Such men as Mr. Mackie has mentioned undoubtedly were well trained and well drilled, and no doubt their first drilling and training came from some train dispatcher. Those are some of the responsibilities of the dispatcher. He has many more that have not been mentioned and he is entitled to our fullest support and sympathy.

THE CHAIRMANS We thank Mr. Daily for his remarks; he need not make any apologies for his oratory. I would say for the information of himself or others who are not familiar with our practice, that copies of the stenographers notes of all remarks made are sent to the speaker for correction, so that they need not be afraid to say anything in their own language; it can be sent back to us as they wish it to appear in the proceedings.

MR. H. C. HOPE (Supt. Telegraph & Signals, C. St. P. M. & O. Ry.): Mr. Chairman, I am not prepared to discuss the very able paper read by Mr. Mackie. I will say this much, that there is more truth than poetry in what Mr. Mackie says. I endorse what Mr. Dailey of the C. & N. W. Road has said; Mr. Dailey having had experience as Chief Train Dispatcher, Assistant Superintendent and Division Officer and now Superintendent of Telegraph of his Road and obliged to furnish the operators for the dispatchers. I am glad to see him take both sides as he fully appreciates the trouble the dispatchers have with the operators and the operators with the dispatchers. I have enjoyed this paper of Mr. Mackie's and would like to hear some of the others discuss the matter. I thank you very much.

MR. P. H. PECK (C. & W. I. R. R.): I came very near to being a dispatcher once. I carried messages for a train dispatcher in 1859.

There are a great many things that the train dispatcher must know: he has to know his men; he has to know his engineers and conductors. I used to have a particular friend who was a great train dispatcher; he would sit in his office and comment on the men as they came along. "There is a man," he would say, "who has his engine fired up ready to go," and "There is another man, I will run him in; after he gets an order he will get a cup of

coffee, oil up his engine, and wili tell a joke to some farmer; he is never ready to go, so I will let him lay up." And that is the way with a train dispatcher; he must know the characteristics of his man, A train dispatcher is like every other man—he is human. There was one case where I overheard an engineer express himself about being laid up by a dispatcher, and by the way he spoke I thought they would eat each other, and I waited around to see what would happen, but when they got together, they just pulled out cigars and there was no fight; they made all their fight over the wire. As a gentleman said this evening, if they will do less fighting and more business, they will get better results. Our superintendent, Mr. Warner, was at one time a train dispatcher. He related to me an incident of an engineer who always had something the matter with his engine, or with himself, and would stop at all water tanks. The train was running in three sections. The engineer of the second section came into his office and asked who was in the lead, and was informed that Brown, the engineer above referred to, was in the lead and that Smith was following him as third section. "My God," he said, "Brown stops at every water tank and works on his engine; Smith does not see one-half of them and there is never anything the matter with his engine; there must be good flagging tonight to save our wav car."

Mr. G. H. Groce (Asst. to the General Manager, I. C. R. R.): I have listened with a great deal of interest to this paper on the subject of train dispatchers, their trials and tribulations, so ably presented by Mr. Mackie. I would be a traitor to my early railroad training if I did not back him up in everything that he claims for the train dispatcher. It is probably ten years since I was actively engaged as a trick dispatcher but I still take a great interest in the work and I am frequently reminded of the old times. As an example of this I recall that about two weeks ago I was standing at a little station on our line where a freight train was on the siding awaiting movement, and because the train dispatcher had evidently given it the right of way over all the other trains on the road the conductor came out of the telegraph office and made this remark. "Hell, that train dispatcher could not make a meeting point between a thirsty Dutchman and a stein of beer."

I had many trying experiences in my dispatching days in trying to handle trains with old wooden engines on railroads not having sufficient passing sidings and I expect that by reason of the profanity which seemed necessary to help things along I will, when I die, be in a position like that of an old Irishman which I recently heard of. It seems that this Irishman had been sick and having a large number of anxious friends a bulletin board was placed on the outside of his house describing at intervals his condition. The bulletin stated that at 2:00 o'clock he was very sick; at 3:00 o'clock he was worse; at 4:00 o'clock he was unconscious, and at 5:00 o'clock

the bulletin stated that he had gone to heaven. This Irishman had an acquaintance living nearby who was not very friendly toward him and in passing he saw the bulletin board and made an additional report "8:00 o'clock, great excitement in heaven, Murphy has not yet arrived."

There are so many important features in Mr. Mackie's paper which might be discussed with profit that I fear to start in on the subject. As a general rule taking the paper as a whole I strongly back up what Mr. Mackie has said. I think, however, that the matter of a trainmaster's recognition as being above the train dispatcher not a thing of great importance. The advancement of the train dispatcher is, to my mind, largely the survival of the fittest. I have known trainmasters who were not train dispatchers but who knew a good bit about train dispatching and were very nice for the train dispatcher to work with and to work for. I have known other trainmasters who were not train dispatchers and whose bearing toward the train dispatchers was so unreasonable that I have declared that I would starve to death before I would work for them for the simple reason that they would not give a dispatcher consideration. I have noticed, however, that as a general rule, the man who does not give recognition to the train dispatcher rarely makes the progress that does the official who recognizes the work and worth of the train dispatcher.

In connection with the matter of train dispatching I think that we are probably nearing an era in the developing of signalling that may do away with many of the trials of the present day train dispatcher. I see no reason why, with the development of railroads, the building of larger and better engines, larger and better shops to take care of the engines, the construction and maintenance of better track, the provision of more sidings and the greater care in the maintenance of the actual physical condition of railroads there should not be more money spent for signalling and that such signalling should be designed not only to prevent accidents, but to assist in the operation of trains. There are a number of different kinds of signals adapted to different kinds of track, double, or three or four track operation or single track operation. The train dispatcher is of course necessary on a double track or for any number of tracks, but on a properly signalled double track line a train dispatcher does not need to give any orders whatever. The system of handling by the standard train orders, trains on a double track will soon be obsolete, and it is a matter of some wonder to me that this system is in use at the present time. The elimination of the train order, however, means that signals should be properly located and properly maintained and operated. This same development will also be true in the case of single track operation. A properly constructed single track with all of its switches controlled by interlocking levers and properly protected by signals can

be operated to greater advantage without train orders than with them. There are some of the lighter lines, branch lines that probably do not have sufficient traffic to justify a large expense for signalling upon which the system of handling trains by train orders will continue unless such lines should be compelled to go to signalling through some Federal or State legislation, but the main single track lines will surely come to some kind of signalling that will assist the dispatcher and make easier his labors.

Years ago, while working as a dispatcher, I recall very well that I cussed the first installation of signalling that was placed on the road where I was working, because I thought the signals delayed trains and was useless, and the signals of those days and the manner in which they were maintained in a manner justified this, but the development of late years in the reliability of signals is not to be questioned and we know that proper signals will lighten the burdens of the train dispatcher. It is possible to so arrange a single track railroad that it might be operated as safely as though it were a double track without train orders and with a dispatcher that should simply sit at his table and direct the movement of these trains. He will then probably be called a train director instead of a train dispatcher and probably, when his burdens are lightened and he is being paid more salary there will be more glory given him.

The character of the man has a great deal to do with his advancement and I believe that a train dispatcher's training is of very great benefit to an official advancing in the railroad service. I know a great many dispatchers who have risen from the ranks, some of whom are with us tonight and I know of some who will probably never advance beyond the position of train dispatcher. I recall one dispatcher and I think he is one of the most successful men in the handling of trains as a dispatcher. In a period of seventeen years with which I was acquainted he never gave a lap order or had any accident resulting from a wrong order for which he was at fault and this is probably a very exceptional case. This man, however, while exceptionally good at handling trains, seemed unable to grasp anything above that particular work. As an illustration of this I recall that there was a great extra movement of trains at a large passenger terminal which required a number of freight crews in addition to the usual passenger men. The movement of this large number of trains was uncertain and kept all the men guessing as to when the crowd would break and require movement. After waiting some little time the officials in charge decided that they would attempt to remove some freight which was accumulating by using some of the freight crews who had been placed in the passenger service. It was of course necessary to bring to that particular point cabooses for the use of these crews and to arrange for this the dispatcher was called up and asked as to the location of these cabooses. His reply was "if there is a caboose car on this rail-

road I do not know it." His mind had evidently gone beyond the actual work of directing the movement of trains and he seemed incapable of appreciating the numerous requirements incident to the handling of a railroad proper. It seems to me that we have to draw a line between those dispatchers who are simply capable of performing their duties as dispatchers and those dispatchers who take an interest in everything connected with the management and handling of a railroad. However, upon the whole I think the train dispatchers are brilliant fellows and as Mr. Mackie has put it they are hard working and deserving of advancement and I should say that all of them should be paid more salary than the standard train dispatcher's wages of today.

THE CHAIRMAN: Mr. Bullard, may we hear from you?

MR. S. K. BULLARD (Supt. Telegraph, M. K. & T. Ry.): I do not know that I can add anything to what has already been said. Mr. Daily has expressed my ideas on the subject.

THE CHAIRMAN: Mr. Mackie threw several bouquets at the Burlington; I would like to hear from the Burlington if they have anything to say.

MR. J. A. CARNEY (C., B. & Q R. R.): I do not know of anything that will produce grief for the train dispatcher any quicker than an engine that is not doing its share towards getting a train over the road. Mr. Mackie has pointed out that the train dispatcher is in a way a supreme officer, and we all recognize it, and it is absolutely necessary that it should be so, but at the same time there is a tendency on the part of some dispatchers to try to dictate to the roundhouse what individual power shall be used on individual trains. I do not know of any man who is more competent to judge of the condition of an engine than the roundhouse foreman, and while an engine may have been doing most excellent work, it may come in on a train and be on time, in a condition absolutely unfit to go out again within a reasonable length of time.

A case came up some years ago where a certain engine running on a certain passenger train, a very important train, had been classed as little bit the best engine running between the specified points, and the dispatcher sent a note to the roundhouse foreman that he wanted that engine to go out on the next west-bound train. It so happened that while going from the depot to the roundhouse the engine burst a flue, and she had a broken spring. It was impossible to repair the engine and get it ready for the train it was ordered for and another engine was sent in its place. The dispatcher did not feel that he had a square deal on that matter and that the engine asked for should have been furnished without question. As a matter of fact the engine which did go out did the work just as well as the one asked for. There is a tendency to dictate to the roundhouse what individual power should be used and I think it is wrong. The dispatcher should say to the round-

house foreman, "We want a Class A engine, or Class C, or Class D engine for a specific purpose," and let the roundhouse foreman say which engine shall go out. A competent roundhouse foreman will give the best engine that is to be had for that purpose.

Mr. P. W. Drew (Supt. Tel. Wis. Cent. Ry.): Gentlemen, I am not prepared to make a speech, but I am prepared to say that I am very glad to be with you this evening. There was a time about thirty years ago when I used to know nearly every railroad man in Chicago, but since I moved to Milwaukee I do not know quite so many Chicago railroad men as I used to. I have been very much interested in this paper of our old friend, Mr. Mackie, who is certainly well qualified to present the side of the train dispatcher. There is one thing about the train dispatcher that we admire more than any other one thing, and that is, he knows how to adjust himself and to change his plans. In any other class of business we can prepare ourselves, we can make our plans and can work up to those plans, but when those plans are knocked out suddenly and unexpectedly, there are very few of us who can recover ourselves as a train dispatcher does when he has to start in on new plans and work them out successfully. I have seen dispatchers who had their sheets all prepared, knew just where one train was to meet the other and had arranged all the way up the road for meeting points that they were to make. Suddenly some engine failure, some little breakdown or something would spoil that whole combination and then to see them in almost a moment's time rearrange their schedule, dropping everything that they had planned for, starting out with a new one and working that out to its successful conclusion, has always won my ardent admiration. I think train dispatchers who do that (and there are many of them that have to do it; it is part of their business), I think they are deserving of a great deal of credit. I have a great admiration for a good train dispatcher, and a great majority of them are good. I know once in a while people standing on the side track, not being able to move, find the easiest thing in the world to do is to "cuss" the dispatcher, but perhaps there are some things going on that they do not know of, fifteen or twenty or forty miles away that have caused that trouble and delay.

I believe, too, as somebody has said here, in the power of a word of praise. I think none of us give enough of that to those who are subordinate to us. I know that a little word of commendation does a great deal in cheering up, encouraging and helping a man, much more than that word of blame that we are so ready to give when things do not go just to suit us. I think if railroad officials generally would cultivate that grace, they would find the results certainly beneficial to the service. If a man does a good thing once in a while, not every day in the week, nor every hour

in the day, but once in a while do say, "Billy, that is a good thing, you did well."

MR. G. C. KINSMAN (Supt. Telegraph, Wabash Railroad): Mr. Chairman, Mr. Mackie's very able and interesting paper brings to me many reminiscences. It takes me back to the year 1881, at which time I gave up a position as Chief Dispatcher to take another which paid a great deal better salary, but not, however, for the salary so much as because it gave me a little more time to get acquainted with my family. Soon after I went into the telegraph department, we had a change of management and got a general manager who was a very brilliant man, a very able railroad man, but he had little peculiarities, one of which was that he thought every train dispatcher was in league with Satan, was utterly past redemption. I remember being out on the road with him, I think about a week after he came on the line, and to emphasize his opinion, a telegram came in from the Western Bureau to the Superintendent stating that a terrific gale of wind was coming from the west, giving warning, such as we frequently receive. I handed this to the general manager Talmage, who looked at it a moment and said, "Don't let that bother you at all; it will have to come over the Middle Division and the train dispatchers will lay it out." (Laughter.)

It turned out shortly after that his opinion of the train dispatcher was changed because of rules he had made which no dispatcher could work up to. For instance, the first thing he did after he came on our road was to make a new time card and take away time orders. He said he had never had a time order on any railroad he had worked on, and he never would have any. The result was that every train was laid out, although we had a fine set of dispatchers, and the situation got pretty bad. After a few weeks, considerably to my distress, I was called upon to fix up a new set of rules, and it was a situation I did not know just how to handle, but after conferring with our General Superintendent, at that time Mr. Wade, he said, "You go ahead and do the best you can; I do not think you can succeed, but you must obey orders." So I made the set of rules which was to be submitted to the General Manager and I put in the time orders. They were somewhat different from those we previously had, but the only ones that I thought would do the work. I took them to St. Louis and with the General Superintendent went to see the General Manager, who looked at the rules. The first one he came to he said, "There is that d—n time order; I have never had a time order and I never will have it." I said, "Well, Mr. Talmage, the time table is simply a bunch of time orders; what is the difference?" He scratched his head a little and finally turned to Mr. Wade, and said, "All right, let her go. If they break up the engines and trains, we will not lose very much, because they are pretty nearly all standing still now." We got

along very well by that arrangement and he changed his mind very materially, so that before his death he thought train dispatchers were pretty decent, respectable people.

But, putting joking aside, it is a fact which I do not believe any one can dispute, that the train dispatcher today is over-worked and illy paid. It was my lot not so very long ago to make an investigation over some eight or ten railroads, upon an order from the General Manager, of the dispatching service on those roads, and in but one instance did I find a place or a road where the chief dispatcher did not tell me that he was so busy that he could not even watch the dispatchers, could not check the orders, could not get out on the road, could not see his operators as he would like to. It certainly is true, as Mr. Mackie has stated, that the dispatcher ought to have better recognition. If he is not a good dispatcher we should get rid of him; if he is a good dispatcher, he is cheap at any price; if he is not a good one he is dear at any price. And there is no better way to get good ones, no better way to recognize ability than to pay for it.

MR. B. H. JEFFRIES (Wabash Ry.): This is a subject that always interests me, of course. A few of the obstacles that the train dispatcher has to overcome have been clearly pointed out here, especially by Mr. Daily in speaking of the operators and how the dispatchers should train them. I do not quite agree with him; I think the kindergarten ought to be somewhere else besides in actual service. A man ought to know something about his business before he starts out to take an office, and that he at least ought to be a competent operator; that we know is not the case in many instances today, and one of the greatest troubles the dispatcher has is trying to get orders and messages through operators who open their key and say, "What?" and all that sort of thing which takes time and lays out trains.

A little instance occurred a good many years ago when I was working at a little station on the Big Four Road. My brother was working the third trick and an operator from some commercial school was starting his first night at railroad work. They were using the old single order system at the time. The dispatcher sent an order saying, "Red flag first No. 57," and the response monent's time he told him to red flag second section No. 57; he re-came from the operator, "I. I. 13 Red flag first No. 57." In a few peated it. In a few minutes he called up again and told him to red flag first section of No. 24, and got the usual response. In a little while he called him up again and told him to red flag the second section of 24. The operator said he could not do it; he immediately asked him why, and he said, "All three of the red lanterns are out on the platform now and I have been looking all around and I cannot find any more." (Laughter.) That is perhaps an extreme case of an incompetent operator, but there are

lots of them who, even though they may be efficient operators, do not understand train rules.

Another class of people that work hardship on the train dispatcher are engineers who do not do regular work; who break a record one day and fall down the next five under apparently the same conditions. You who are train dispatchers are acquainted with that class of men. We have another class of men who are really good men, good average runners; you can bank on them and can figure on them, and if we have good operators to back them up, they will be less delay to trains.

Mr. J. L. Davis (Supt. Telegraph, C. & E. I. R. R.): Mr. Chairman, I thank you very kindly for the invitation that was extended to me to address the members of the Western Railway Club, on this occasion, both in writing and verbally. I regret, however, that on account of being out of the city until today that I did not receive the invitation, and inasmuch as the Superintendents of Telegraph called a meeting in Chicago, and we have been in session all day, I consequently knew nothing whatever of what Mr. Mackie's paper contained until I heard it read tonight. I think we who have served our time as train dispatchers and are here tonight, have thoroughly enjoyed what has been said, but it occurs to me that there is one thing that has been left slightly undone, and that is, the gentlemen who have spoken have not put sufficient stress upon what I consider the most important of all, and that is a perfect understanding of the rules and regulations of the transportation department. The train dispatcher must not only know the enginemen, the capacity and speed of the engine, the capacity of all his sidetracks and all that, but he must have a perfect understanding of the rules, and he must expect the same understanding from the men with whom he works and the men who work under him, or he will not succeed.

I recall just at this time a story that I heard not a great while ago about a Pennsylvania farm that was owned many years ago by a man of little or no ambition, through whose farm there flowed seems that it was the sole duty of that man and his family of big a stream and on that stream there floated a thin scum of oil. It boys to go to that stream daily and skim from the surface of the stream enough oil to bottle and send to a refinery or a druggist many miles away. They would place boards across the stream so that the oil might accumulate. While they were doing that one day a man who was a stranger in that territory walked in and the farmer immediately began to tell his hard luck story, the soil unfertile, and all that sort of thing, and finally he offered to sell the farm to this man for little or nothing compared to its real value. The deal was quickly consummated, the man who purchased the farm immediately mortgaged it for more than double the amount that he had paid for it; with the borrowed money he was enabled to drill holes, and those holes originated what is today the great

oil fields of Pennsylvania. Now, while I have heard this talk tonight about railroading, it just occurred to me that that story serves as a lesson, or as a splendid illustration for railroad men. One fellow contented with that which floats upon the surface, the other fellow determined to dig down and see what lies below the surface. It is true with railroad men in all branches of the service; some of them you cannot keep down and others you cannot raise. Let him be train dispatcher or engineman, telegraph operator, conductor, brakeman or switchman, or anything you want to call him, if the man is determined to find out why certain things are done, if he will realize that there is a reason for all things and find out what that reason is, especially if it comes within his line of duty, you may depend upon it that that man will rise, and a few such men have been mentioned by Mr. Mackie tonight. We have men of that kind in the service of every railroad in the country today; they are going to rise and you cannot keep them down. Many of them are in train dispatching offices; they go to work thirty or forty minutes before the specified time; look over the special instructions, check up everything that is on the sheet before they are expected to take hold, and when they do take hold of the reins, you may depend on it, the trains are going to move; movements slightly out of the ordinary are not going to worry them; they will not get excited if the trains bunch up; they have foreseen it and planned accordingly, and are ready to take care of it.

On the other hand, you will find the fellow who comes in on the very last minute,—usually not on the last minute, but anywhere from one to eight or ten minutes late. He comes in and he says immediately, (instead of taking the transfer as he should, with deliberation), he says, "I have got them, let her go." The fellow who has written out his transfer leaves the office; this man sits down and the first thing he knows the trains are beginning to bunch up, then he commences to send his orders just as he would send an associated press dispatch; the ordinary railroad operator is not competent or capable to take train orders, or put them down in that sort of way; they cannot write them so fast, when they are taking as high as eleven to fifteen copies; nobody can do it and put it down accurately and plainly so that the engine man who has to read the order by dim light can read it as he should read it; the operator in consequence "breaks" and the dispatcher begins to jump up and down, hammer the key and all that sort of thing. You may depend upon it, when you see a man working like that in the train dispatcher's office, that the job is too big for him. He has no business as a train dispatcher; he ought to do something else. You will find the same thing with enginemen, and conductors; some of them cannot get over the road without trouble; they "double" the hills before they get out of the yard while others work month

after month in a way that makes everybody glad to have them around.

We might talk for a long time along the same lines, but it is growing late; however, I will say very positively before closing, that it is my opinion that we have, on the different railroads, a great many good train dispatchers, who are the most valuable asset of their superintendent, who should have, in many cases, more consideration than they are getting at the present time. (Applause.)

Mr. W. E. Symons: In line with the remarks of the last speaker it has occurred to me, that possibly, it would not be out of order to suggest, that the gentlemen named, as now occupying high positions as railway executives, and having come up from the positions of train dispatchers, would have in all probability advanced to the same, or equally as high a rank, had they commenced railroad-work in any other branch of the service, such as transportation, locomotive, mantenance of way, engineering, mechanical, traffic, or legal department, and following that line of thought, if you will pardon the digression, I would suggest, that it would be an excellent thing for the Club if its officers could secure from representative members of these various branches of the railway service, papers pertaining to their scope of work, usefulness and importance, either in the construction or operation of a railroad from their standpoint or angle of vision. Papers of this kind coming from the various departments with the claims as ably presented as Mr. Mackie has presented that of the train dispatchers would, if combined in a volume be a very valuable addition to a railroad library, and might be called a text book or the true status of the various classes of employes on Railroads as taken from their angle of vision.

Mr. E. A. Chenery (Mo. Pac. Ry.): This matter has been so thoroughly discussed that I am satisfied I cannot add anything that would be of particular interest. I recall, in listening to the names mentioned by Mr. Mackie, one of the bright lights from the ranks of train dispatcher, speaking of Mr. Garrett—I do not believe Mr. Garrett was a train dispatcher, but he certainly had a great deal of respect and admiration for that branch of the service. I think it was he who said that if he had his way he would build a train dispatcher's office in the top story of the building and so locate it that it could only be reached by a ladder, and after the dispatcher was on duty the ladder should be pulled upstairs. The idea was to prevent the dispatcher from being interfered with, as has been mentioned tonight, by reason of conductors and other people, telephone matters and things of that kind that would probably distract his attention.

The Chairman: We have another very excellent paper for

this evening, but I believe, unless objection is made, that it will be better to defer it until our next meeting. There will therefore be an opportunity, as it is not very late yet, for anybody desiring to whack the dispatchers a little, as they have been getting all boquets so far, and if there is anything to be said on the other side, now is the opportunity before Mr. Mackie is invited to close his discussion.

Mr. Peck: One thing in which the train dispatchers have the advantage over a great many of us who are railroading is that they have to deal with people who can talk their language. There are many men in our department that require interpreters. If you undertake to talk to them, "Boo," is all you can get out of them. The dispatchers only have to deal with boys or girls perhaps, who can all talk their language and can read and write, and I think there is a great deal of satisfction in that.

Mr. Daily: If you will pardon me, there is a gentleman in the room with whom I have had many a tussle and many a wrestle as a' train dispatcher and who expressed himself very forcibly in regard to his opinion of dispatchers at that time, and I think that it would be entertaining to hear Mr. Harry Wayne of the North Western express his opinion of train dispatchers in general, when they insist on ordering engines out of the round house before necessary work can be done on them, reporting engine failures that are not failures and making remarks about the motive power.

A Member: He left the room about ten minutes ago.

Mr. E. W. Pratt (C. & N. W. Ry.): I was not fortunate enough to be present to hear the early part of this discussion but one of the remarks that has just been made with regard to getting up on the top story and pulling up the ladder recalled to my mind the difference between the modern train dispatching and that of a few years ago, which seems to me to retrograde. It is well conceded that no train dispatcher can be thoroughly successful without the hearty co-operation of the train men and engine men on the road. If they have a feeling that he is arrogant and exercises poor judgment, they are going to do a great deal to hurt his record and as well preventing the good results that the company should obtain. I believe it is all right for the trick dispatcher on duty to be so segregated that he will not be interrupted when he should not be, but I would like to suggest that when he is off duty, that once in a while he go out on the road and rub up against these enginemen and trainmen. He will find that they are good fellows and they will find that he is human and there will be a sympathy between them that will redound to their mutual credit and advantage and to the benefit of their employers.

Mr. T. S. Reilly (Railway Review): We have a Cuban insurgent with us tonight and when Bill Taft got off the lid he escaped. Down there he was Superintendent of Telegraph of the United Railways of Havana; they changed from telegraph to telephone service, I believe. We would like to get him up and look him over.

Mr. F. A. Saylor (Ed. Ry. M. M.): Gentlemen, I am very much pleased to meet you. While I cannot say very much, I can confirm the opinion expressed here tonight in relation to a sort of a signal block system. In Cuba they do not use the automatic signals, but depend entirely on the dispatcher for train service; there are no train orders, our system is what they call the Via Libre, or right of way. We did try the telephone over one division, but found that it was not successful, because we could not depend on the men interpreting the orders correctly. Of course everything is in Spanish and a great many of the Spanish words sound very similar and they have a very different interpretation, so we joined issue; we use both the telephone and the telegraph, using the telegraph entirely for train orders, that is, the dispatching, and using the telephone in conjunction with it for communication between stations, that is, local business from station to station.

Our system for advancing and praising our men was rather a laudable one, because our praise was in the form of a pecuniary advancement. A man started in at the very lowest station on the line, and as he showed his ability he was advanced from one place to another. I think our present Chief Dispatcher started in at the lowest station of all and is now of course at the head of his line. The difficulty between roundhouse foremen and the dispatcher, which was mentioned tonight, we overcome very successfully by making the roundhouse foreman's word in regard to an engine for a train, final; it is left entirely with him as to what engine he would supply for a train, as long as it is in the class called for by the dispatcher. I think that our system down there has been a very successful one for a single track road; all the roads down there are single track of course, but they are advancing, getting modern ideas now days; the United Railways of Havana are consolidating a number of the smaller lines and have now brought out one of the newest things that has come up before the public, and that is a trunk line electric railway. This is backed by American capital and is operated on steam railway lines, but it is entirely a trunk line railroad operated by electricity. They have just started in operation that line, and of course we have not got much data about it and their signaling system has not been completed, but I think that they will use the system that they are now using over their steam lines practically, I mean the block system.

Mr. B. E. Jones (Engineer C. B. & Q. Ry.): I did not arrive in the city until 9 o'clock and not having had the opportunity of hearing the paper, under discussion, read, nor the time to read the advance copy, I am not in a position to discuss it.

I call to mind an incident that occurred to me in connection with dispatching trains. Last fall I was pulling a fast mail on a very foggy morning. The dispatcher found the track obstructed, and it was necessary, in order to avoid delay, to run the train on the reverse track (or east bound). I was only four miles from the point where he wished to take the crossover, when he called up the operator and gave him the order. The operator went out and lined up the switches and started for the semaphores, but realizing that he could not get them raised in time to slow me down, he ran back and lined up the switch, just in time to prevent my taking the crossover at a speed of 60 to 65 miles per hour. The block being against me, I stopped and backed up. The operator gave me my orders and then informed me of the conditions. I thanked him for his good judgment in this case; and also wrote the superintendent, stating the circumstances, the condition of the weather and that I thought the dipatchers should know conditions of the weather before crossing trains over or putting them on sidings; also that I believed the operator should be commended for hs good judgment in lining up the switches. A short time after that, I received a letter from the operator thanking me for the letter I had written the superintendent, as it seems, he, the superintendent, had acted on my suggestion and had given him a day position.

Mr. W. G. Wallace: The train dispatcher, if he is efficient in his duty, is one of the greatest helps to the mechanical department, as well as a profitable investment to a railroad company. The train dispatcher who is familiar with the men and the power on his division to handle is a good dispatcher; he is better informed as to the power almost than any officer in the mechanical department outside of the traveling engineer. He is familiar with the engines and the men and how they do their work. Naturally he will favor the man that favors him. The engineman that he can depend on to make the meeting point always get the help. The engineman or the conductor who asks for orders and then is not ready, makes it bad for the train dispatcher, because he figures that he ought to make the meeting points without laying the other man out; that he could if he had been ready to proceed when the order was complete. It does not take the train dispatcher long to find the men that he can rely on and the men that he will not help unless he is absolutely certain they have plenty of time to get their train in the clear without delaying other trains. Every engineer and every conductor ought to have a reasonable pride in their record.

and I think they have. A great many train dispatchers anticipate the meeting points in advance and if they find one train is falling back a little, and the other fellow is making a good run, if he is the right kind of man he will help him, therefore the good man gets the help and the poor one has to take the layout.

A train dispatcher can give a tonnage train a reasonably clear track and a train dispatcher who will stop that train every five miles will make a difference in the coal record, per one hundred ton miles from twelve pounds of coal, where the train proceeds without unnecessary stops, to twenty-four pounds of coal per one hundred ton miles when the train is stopped unnecessarily. That means a great deal for the mechanical department, and I think that the train dispatcher ought to come in for his share of the credit in locomotive performance, because every time that a train dispatcher cuts out a stop for a tonnage train or a fast train, he saves that much money for the road. Every time he stops a train unnecessarily, he is burning up the company's money.

In regard to the praise and a little taffy that we all like to get once in a while, I had occasion to take a message to an engineer who was handling a rather important train. He fell down slightly on his schedule through no fault of his, but shortly afterwards he made an excellent run. The chief dispatcher noticed it and asked me to mention it to the engineer and tell him that he appreciated the run he made. The engineer said, "You go back and tell him that I did not try to make a run that night; everything was favorable, the train ran well and I did not work the engine nearly as hard as I did the night he found fault when I fell down eight minutes on that run." I believe the only way to give a man credit—of course a compliment is all right, but the best way to give them credit is as our friend from Havana has said, by giving him a little better position; that is the most substantial reward a man can have for a duty performed well. I believe that every man in both the operating and mechanical departments appreciates a good train dispatcher, and he is a valuable man to a railroad. If he is a good one, there is nothing too good for him, but if he is a poor one, he is dear at any price.

THE CHAIRMAN: If there is nothing further, I will ask Mr. Mackie to close, if he has anything to say.

MR. MACKIE: There has been so very little, comparatively, in the way of adverse criticism that I do not know that there is very much to say. I concede all that the various speakers have said in regard to the shortcomings of the train dispatchers. There is no question whatever but that a good train dispatcher should cultivate proper relations with the men who are subject to his orders, who handle the trains that he moves. There is no question but that he ought to be on proper terms with those men, that he ought to treat them in a gentlemanly manner, that he ought not to criti-

cise them unfavorably without some knowledge of the conditions that produce the results which seem to call for criticism.

One of the things that train dispatchers in general have found reason to complain of, one of the things that I did not touch upon in the paper that I read, was the fact that it is not infrequently the case that train dispatchers are blamed for delays that occur on their districts before investigation is had to whether any blame attaches to them or not. I have in mind one instance where delays occurred on a certain division of a certain road one day and the general superintendent shot a message to the division superintendent to the effect that he was not satisfied with the way the trains had moved that day and that it looked to him like a case of poor dispatching; he did not know anything about the circumstances, or the details of the case, and I have good reason to believe that the train dispatchers on that division felt as though they had received a slap in the face that was undeserved and unwarranted. There was no blame, under the circumstances, to be attached to the train dispatcher. I have no doubt that engine men and conductors feel the same way in regard to too hasty action of the same kind on the part of the train dispatcher. He never ought to be guilty of any action of that kind. However, I have known of cases where train dispatchers have been guilty of just such things as that. It is these little things that are forgotten two minutes after they occur that are most likely to create ill feeling between the various classes of railway men, hasty, inconsiderate action, hasty, undeserved criticism; whoever is guilty of such action is blamable and I do not excuse the train dispatcher any more than I would excuse any one else under those circumstances. There is one duty devolving upon every railroad man in his relations to every other railway man with whom he has dealings, and that is the duty of being considerate and gentlemanly. That is one of the things that as railway men, all of us ought to take to heart and remember, and if we would all live up to the Golden Rule of doing as we would be done by, things would go on very much more harmoniously than sometimes they do.

I feel like congratulating myself upon the fact that on the main points of the paper I have read, the discussion it has undergone tends to confirm my argument rather than to confute it, and to recognize, in a way that has given me much pleasure, the claim of the train dispatcher to larger appreciation and consideration for the exceedingly important charge entrusted to his hands.

The Chairman: I believe that our thanks are due to Mr. Mackie and also to gentlemen who have so ably discussed the paper.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897
Library, 390 Old Colony Bldg.

Published monthly, except June, July and August, by the Western Railway Club, 390 Old Colony Bld'g Chicago, Illinois

Club meets third Tuesday in each month, except June, July and August

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Vol. 19—No. 5 Chicago, January 15, 1907 $2.00 Per Year 25c a Copy

The regular meeting of the Western Railway Club was held at the Auditorium Hotel, on Tuesday evening, January 15, 1907, President H. T. Bentley in the chair.

The meeting was called to order by the President at 8 P. M.

Among those present the following registered:

Ames, C. F.
Baker, F. L.
Barnes, C. A.
Barnhart, A. H.
Barnum, M. K.
Beless, J. T.
Bement, A.
Benedict, B. W.
Bentley, H. T.
Borrowdale, J. M.
Bryant, G. H.
Burnett, R. W.
Cardwell, J. R.
Carney, J. A.
Carlton, L. M.
Chisholm, J. E.
Christenson, A.
Cooke, W. J.
Cooledge, F. J.
Cota, A. J.
Crownover, G. M.
Cunningham, A. J.
Deffenbaugh, Chas.
DeGroot, Jr., E. H.
DeVoy, J. F.
Dewey, L. R.
Dolly, J. M.
Donovan, A. G.
Dowd, Willard
Eayrs, T. C.
Farmer, G. W.
Fenn, F. D.
Flavin, J. F.
Fogg, J. W.
Fries, W. F.
Fry, C. H.
Gowing, J. P.
Haig, M. H.
Higgins, C. C.
Hopkins, G. H.
Hungerford, J. S. Jr.
Jeffries, B. H.
Jenks, C. D.
Johnson, A. B.
Johnstone, H. C.
Jones, L. E.
Kelly, J. W.
Kerwin, E. M.
King, C. H.
Lancaster, J. R.
Little, J. C.
McAlpine, A. R.
Maher, P.
Meeder, W. R.
Moody, W. O.
Munger, E. T.
Neff, J. P.
Ott, O. W.
Park, S. L.
Peck, C. L.
Peck, P. H.
Phipps, D. L.
Rutherford, F. H.
Seley, C. A.
Setchel, J. H.
Sharp, W. E.
Sipp, B. F.
Slater, F.
Slaughter, H. W.
State, R. E.
Stewart, H. A.
Stimson, O. M.
Stott, A. J.
Sweringen, F. H.
Symons, W. E.
Taft, R. C.
Taylor, H. G.
Taylor, J. W.
Thomas, C. W.
Thurnauer, G.
Tinker, J. H.
Towsley, C. A.
Vincent, M. M.
Vissering, Harry
Webb, E. R.
Wheeler, G. W.
Wickersham, R. S.
Williams, M. E.
Winslow, H. L.
Woods, E. S.
Zealand, T. H.

THE PRESIDENT: The first order of business will be the approval of the minutes of the last meeting. As these have been published and distributed, unless there is objection they will be approved as printed.

The next order of business is the report of the Secretary.

THE SECRETARY: Mr. President, I have the following membership list:

Membership, December, 1906	1,325
Withdrawals—Non-payment of dues	6
	1,319
New members approved by Board of Directors	33
Total	1,352

NEW MEMBERS.

A. O. Smith, Engineer, C. M. & St. P. Ry., Hilbert Wis.	M. E. Williams
G. A. Harmon, Engineer, C. M. & St. P. Ry., Milwaukee.	M. E. Williams
H. R. Calehan, Engineer, C. M. & St. P. Ry., Savanna, Ill.	M. E. Williams
H. D. Kelley, Demonstrator, C. & N. W. Ry., Chicago, Ill.	T. E. Warnock
Wm. Dickson, R. H. F., Lake Terminal R. R., Lorain, Ohio.	B. B. Cargo
H. J. Stow, Western Agt., Star Brass Mfg. Co., Chicago, Ill.	J. W. Taylor
W. H. Edgecombe, Care of Counseling Engr., A. T. & S. F. Ry.	C. B. Goode
C. H. Carman, A. B. Foreman, C. & E. I. R. R., Danville, Ill.	J. H. Tinker
N. E Salsich, Repr. Penna. Steel Co., Chicago, Ill.	J. L. Woods
A. D. Page, P. A. E., C. R. I. & P. Ry., Chicago, Ill.	A. K. Shurtleff
Chas. S. Corning, Railway Supplies, Chicago, Ill.	Sanford Keeler
Geo. A. Store, Mgr., Norton Co., Chicago, Ill.	L. R. Dewey
O. B. Englisch, V. P. & G. M., Erie & Mich. Ry. & Nav. Co.	B. F. Sipp
H. E. McCormick, Repr. Penna. Steel Co., Chicago, Ill.	J. L. Woods
R. E. Belknap, Agt., Penna. Steel Co., Chicago, Ill.	J. L. Woods
Walter D. Smith, Foreman, C. & E. I. R. A., Danville, Ill.	C. F. Schraag
G. G. Gilpin, Draftsman, C. B. & Q. R. R., Riverside, Ill.	C. B. Young
M. J. Kelly, Gen'l Foreman, P. M. R. R., Chicago, Ill.	B. F. Otley
L. H. Ledger, Loco. Engr., A. T. & S. F. Ry., Los Angeles, Cal.	M. E. Williams
W. B. Sharp, Loco. Engr., St. L. S. W. Ry., Mt. Pleasant, Tex.	M. E. Williams
J. A. Davidson, Loco. Engr., D. & R. G. Ry., Salida, Colo.	M. E. Williams
Chas. Deffenbaugh, Loco. Engr., S. P. L. A. & S. L. Ry, Los Angeles, Cal.	M. E. Williams
T. G. Lickey, Asst. Foreman, L. S. & M. S. Ry., Chicago, Ill.	E. D. Taylor
John Murray, R. H. F., C. & W. I. R. R., Chicago, Ill.	P. H. Peck
Geo. V. Brown, T. D., Belt R. R., Chicago, Ill.	P. H. Peck
W. H. Robson, Electrician, C. & W. I. R. R., Chicago, Ill.	P. H. Peck
N. B. Whitsel, G. R. H. F., C. & W. I. R. R., Chicago, Ill.	P. H. Peck
F. W. Miller, J. L. Yale & Co., Chicago, Ill.	H. L. Winslow
H. W. Slaughter, C. C., C.&E.I.R.R., Chicago	W. N. Meeder, J. A. Carney
G. E. Van Hagan, V. P., Standard Forgings Co., Chicago.	W. J. Cooke
W. A. Pownall, Water Engr., C. B. & Q. Ry., Aurora, Ill.	J. A. Carney
G. H. Hill, Insp., C. B. & Q. Ry., Aurora, Ill.	I. E. Gardner
O. M. Foster, A. M. M., L. S. & M. S. Ry., Elkhart, Ind.	M. J. McCarthy

WITHDRAWALS.

Jas. O'Leary, Engr., C. M. & St. P. Ry., Babcock, Wis. Nonpayment of dues.
J. P. Peach, G. F., A. T. & S. F. Ry., Ft. Madison, Ia. Nonpayment of dues.
J. D. Maquire, Christensen Engr. Co., New York. Nonpayment of dues.
C. W. Rogers, N. Y. Blower Co., Chicago. Nonpayment of dues.
K. J. Stern, Foreman, C. B. & Q. Ry., Alliance, Neb. Nonpayment of dues.
G. E. Stolpe, Draftsman, A. T. & S. F. Ry., Chicago. Nonpayment of dues.

THE SECRETARY: Mr. President, I have the following communication which I believe it will be well to read at this time:

NEW YORK, Dec. 18, 1906.

Mr. J. W. Taylor, Secretary Western Railway Club, 390 *Old Colony Building Chicago, Ill.*

Dear Sir: I have had called to my attention a statement of Mr. E. W. Farnham, made before your Club at the meeting held on the evening of Tuesday, October 16, at the Auditorium Hotel, Chicago, and in order that a misapprehension may be corrected, I am bringing the matter to your attention and ask that you refer to the published report of Mr. Farnham's remarks before your Club and turn to page 69 from which I quote:

"The New York Central is using our inverted protected third rail with under-running contact, and we present for your information a view of two sections of this rail as it appears near the North portal of the Third Avenue Tunnel, New York City."

The New York Central Railroad Co. is *not* using the Farnham under-running third rail and I quote from a letter dated February 17, 1905, which I addressed to the Farnham Co.:

"Referring to your communication of the 11th, regarding your type of under-running third rail construction and your proposal to install an experimental section near Schenectady: After a careful examination of the full sized model submitted by you, the Electric Traction Commission of the Company feels that it would be unwise for you to incur the expense of this experimental construction in view of the large cost per mile and the number of technical objections to the type you propose to use."

The type of under-running third rail adopted by the New York Central Co., was originated by Mr. Wilgus, Vice-President of the Company in collaboration with Mr. Frank J. Sprague, a member of the Electric Traction Commission, and the details of the construction were developed by the Railroad Co. at its Experimental track near Schenectady.

The type of third rail which was offered by the Farnham Company and rejected by the Railroad Company was substantially the same as that illustrated on page 59 of your transaction and marked for identification Figure 26. This and many similar types were offered by various inventors all of which were rejected because of inherent defects.

I would appreciate it if you would kindly bring this matter to the attention of your Club at its next meeting in order that the mistaken impression contained in Mr. Farnham's paper may be corrected.

Respectfully,

EDWIN B. KATTE.

THE SECRETARY: If there are no objections, this communication will appear in the printed proceedings of this meeting. I do not believe it is a matter for discussion.

PRESIDENT BENTLEY: The letter which the Secretary has just read is a matter that concerns some controversy between Mr. Katte and Mr. Farnum. Of course I do not know the merits of the controversy, and, therefore, in fairness to both gentlemen, we will enter the letter in our proceedings.

I hope you will notice the marked increase in the number of members tonight. It is very gratifying, and it shows that everybody is taking a live interest in the welfare of the Club, and endeavoring to increase the membership. I wish to thank everyone who has been instrumental in introducing members to the Club for their co-operation. The Secretary has something that he wishes to read.

THE SECRETARY: I have a matter that I am very much interested in, and, in which I believe the Club members should more generally be interested, and that is, the Western Railway Club Library.

In 1897 the Western Railway Club became a corporate body in order that it might legally hold the Library which had been bequeathed to it by Mr. D. L. Barnes, whom many of the members present will remember as a hard worker in the interests of the Club. Mr. Barnes was, at the time connected with the Railroad Gazette, and the Library for a good many years was taken care of by the Railroad Gazette in its office in the Monadnock Building.

Two years ago it was transferred to its present quarters, 390 Old Colony Building. Shortly thereafter a movement was started to properly fit up its quarters and the following firms and members contributed a fund to put it in proper shape:

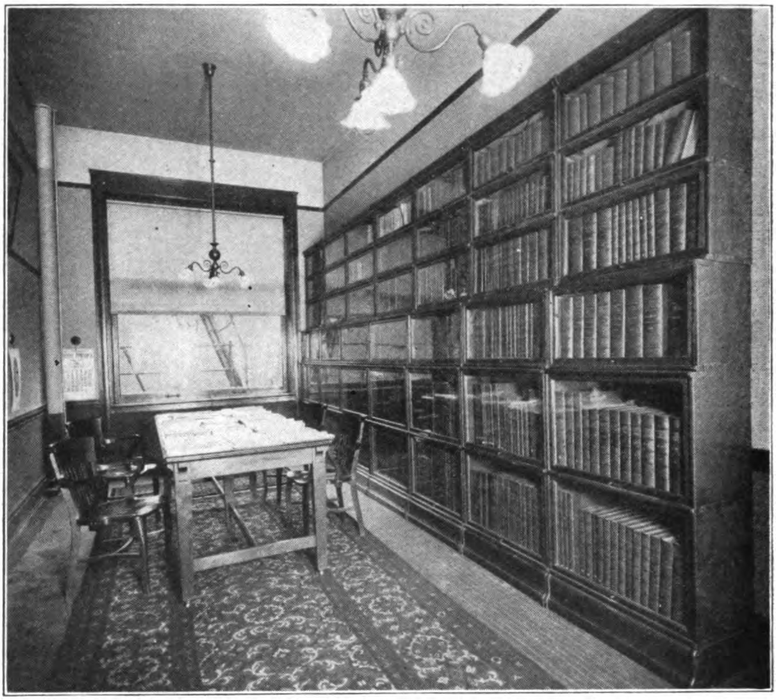
W. M. Simpson.
Fitz-Hugh, Luther Company.
Niles-Bement-Pond Company.
Harry Vissering.
Railroad Gazette.
American Brake Shoe & Fdy. Co.
Railway Appliance Company.
Ashton Valve Company.
W. H. Miner Co.
Chicago Ry. Equipment Co.
Adams & Westlake Co.
J. L. Yale & Co.

Camel Company.
Railway Review.
New York Air Brake Co.
Chicago-Cleveland Car Roof Co.
Ohio Injector Co.
Standard Steel Works.
Murphy Varnish Co.
Railway Age.
Geo. W. Cushing.
Handy Car Equip. Co.
Ingersoll-Sargent Drill Co.
Pyle Nat'l Headlight Co.
Buckeye Steel Castings Co.
C. H. Ferry.
Chicago Varnish Company.
H. C. Buhoup.
Aurora Metal Company.
H. W. Johns-Manville Co.
Westinghouse Air Brake Co.
McCord & Company.
Crosby Steam Gauge & Lantern Co.
Geo. H. Bryant.
E. E. R. Tratman.
Nat'l Malleable Castings Co.

This fund has enabled the Board of Trustees and your Directors to fit up the room in splendid shape, new book cases, tables, comfortable chairs, etc., have been procured, and the various volumes have been so placed that they are easily accessible. On the reading tables are copies of the latest weekiy and monthly engineering papers, magazines, club proceedings and such literature as is ordinarily found in a mechanical library. On the shelves will be found bound volumes of practically all the current engineering magazines, besides many valuable works on mechanical, civil and electrical engineering. Altogether we have some 2,000 volumes.

It is the desire of your Board of Trustees and Directors to call the attention of the members to the fact that the library is so centrally located and at the service of every member. Also to the desirability of further contributions in the shape of engineering literature. We have nearly complete files of all the current papers and magazines, but additions in the shape of special works on engineering would be very acceptable.

We will prepare a new index pretty soon, and I think the members will be delighted to go over to the Old Colony building and see what a nice library they have; it is a good place, if you have an hour to spend, to read the weekly and monthly railroad papers.



A CORNER IN THE LIBRARY

MR. C. A. SELEY (C. R. I. & P. Ry.): I move that the statement of the Secretary in reference to the library be printed in the proceedings of this month, so that those not present will receive the benefit of the invitation. (Motion seconded.)

THE SECRETARY: I would like to make one suggestion which I think Mr. Seley will accept, that this vote carry with it a vote of thanks to the contributors to this fund. The members may not appreciate it until they see the library, nevertheless, I think they can take the word of the Board of Trustees and Secretary in regard to that.

MR. SELEY: I will be pleased to accept that suggestion.

Motion as amended was then put to vote and carried.

PRESIDENT BENTLEY: The only paper we have this evening is one written by a Master Mechanic of the Chicago & North Western Railroad Company on "Engine Failures and Their Report." I am very sorry, gentlemen, that Mr. Dunham is not able to be with us tonight; the last I heard of him he was chasing engine failures up

on the Minnesota and Dakota divisions. Probably after he has been up there a little while he can tell us more about it. In the absence of Mr. Dunham, I will ask the Secretary to read the paper.

ENGINE FAILURES AND THEIR REPORT.

By Mr. W. E. Dunham, M. M. C. & N. W. Ry.

The failure of an engine in service interests so many of the various departments of a railroad directly or indirectly, as well as the travelling or shipping public that every energy is bent toward avoiding them. Shortage of power at times may compel the use of engines on the road which, under ordinary circumstances, would be held for back-shop repairs. These engines then, should not be expected to handle full tonnage, but should be favored to a degree decided upon by the master mechanic in charge. But on the other hand, no engine should be permitted to start on a trip unless the round-house foreman is sure, to the best of his knowledge, that the engine will make the trip successfully if it is handled properly and is not delayed unreasonably. Particularly is this latter condition true in what are known as bad water districts as has been definitely demonstrated. And too, an engine-crew should be given as much consideration as we do our engines. They cannot work perpetually on short hours of rest unless their working hours are made short.

It is naturally during a rush period, whether of short or long duration, that engine failures increase in number and often also in proportion to the total miles run in a given period of time. However, there is a practice which, if once tried under such condition, is usually adopted; i. e., reduced tonnage. There is the consequent increased speed over the road, more frequent attention to engines in round-house, shorter rest hours required by engine crews and more cars handled in the same given time. This is very pronounced on single track roads where a great deal of time is consumed in waiting at meeting points. The train dispatcher can make better meeting points and the little petty annoyances on the engine which make trouble and delays on tonnage trains have no effect. It may be that the cost per ton mile of freight per train is slightly increased, but the cost per ton mile of freight handled in the given period of time is not. For one or two engine failures will quickly wipe out the figured profits of full tonnage trains.

An engine failure, when charged, should be fair and just. The plain fact that an engine has died on the main line or has given up its entire train and has come to the terminal caboose "bounce" is not in itself a cause for the recording of an engine failure. Very often the circumstances are such that a credit mark should be given instead of a demerit. Many of you know of instances on outlaying divisions where up to date round-house equipment is not very extensive and round-houses themselves are not elaborate or frequent,

when an engine has been worked back and forth between outlaying points and the dispatcher wants to make one more trip before sending it in as requested. In an endeavor to help the dispatcher, the engine crew will attempt to do what is asked of them. The consequence is that a train is left on the main line or some important movement is delayed. Is that properly an engine failure, or is it a man failure? Such a case surely is one for investigation first before reporting.

The failure report should be accurate as to facts. These reports originate usually in the train dispatcher's office. Too often the compilation is left until the last moment when every one is in a rush and when the easiest way is to take the notes from the train sheets. As a consequence any occurrence which has annoyed the dispatcher during his trick, is charged as an engine failure if there is half a chance. The result is that the division superintendent and the master mechanic as well as other division officers are bothered with useless letters and memoranda sustaining charges and making explanations of a little petty incident that should have been thoroughly sifted on the spot. This not only wastes valuable time of responsible men, but creates an undercurrent of feeling that often in the end causes bitter enmity. On the other hand, imagine what would have been the result, if the dispatcher had stopped for a moment, before making the record, had obtained all the required information and had considered as to whether the service had been delayed or not, forgetting his own personal annoyance. Every one would have been happy, all had smiling faces and been ready for a dig into the work of the division instead of a dig into the other fellow.

The failure report should be definite as to details. That is, it should not say "leaking" when there are flues that can leak, staybolts that can leak, mud ring that can leak, etc. It should not say "not steaming" when flues stopped up, honey-combed flue sheet, poor coal, green fireman, leaky steam pipes, etc., can be selected as the definite cause.

And finally the record should stay when once made. If the proper care, as rudely outlined above, is taken there will be no such thing as having "failures" cancelled.

But what constitutes an engine failure? Is it not a train failure or delay for which the engine or its crew are alone responsible? With this thought in view, The Chicago & North Western Railway has adopted the following rules for guidance in making, engine failure records.

DEFINITION OF WHAT CONSTITUTES AN ENGINE FAILURE.

1. All delays waiting for an engine at an initial terminal, except in cases where an engine must be turned and does not arrive in time to be despatched and cared for before leaving time.

2. All delays on account of engines breaking down, running hot, not steaming well, or having to reduce tonnage on account of defective engine making a delay at a terminal, a meeting point, a junction connection or delaying other traffic.

DELAYS THAT SHOULD NOT BE CONSIDERED AN ENGINE FAILURE.

1. Do not report cases where engines lose time and afterwards regain it without delay to connections or other traffic.
2. Cases where a passenger or scheduled freight train is delayed from other causes and an engine (having a defect) makes up more time than she loses on her own account, should not be called an engine failure.
3. Do not report delays to passenger trains when they are less than five minutes late at terminals or junction points.
4. Do not report delays to scheduled freight trains when they are less than twenty minutes late at terminals or junction points.
5. Do not report delays when an engine is given excess of tonnage and stalls on a hill, providing the engine is working and steaming well.
6. Do not report delays on extra dead freight trains if the run is made in less hours than the miles divided by ten.
7. Do not report engine failures on account of engines steaming poorly, or flues leaking, on any run where the engine has been delayed on side-tracks other than by defects of engine, or on the road an unreasonable length of time: say fifteen hours or more per one hundred miles.
8. Do not report an engine failure for reasonable delays in cleaning fires and ash-pans on the road.
9. Do not report failures against engines that are coming from outside points to the shops for repairs.
10. Do not report cases where an engine is held in the roundhouse for needed repairs, and called for by the operating department, they being informed that the engine will not be ready until a stated time. Failure to provide that engine before that stated time should not be called an engine failure.
11. Do not report broken draft rigging on engines and tenders caused by air being set on train, account of bursted hose or breaking in two.
12. Do not report delays to fast schedule trains when the weather conditions are such that it is impossible to make the time, providing the engine is working and steaming well.
13. Do not report delays when an engine gets out of coal and water, caused by being held between coal and water stations an unreasonable length of time.

In collecting the information for the failure the engineman and the dispatcher are the first ones concerned. The engineman advises the dispatcher just what is the trouble with the engine and says

what must be done to get the engine to the terminal or place of tie-up. His statement shows whether the boiler, the machinery, or special attachments are troubling, and gives a brief detail of what is wrong. The dispatcher then advises the master mechanic or the division foreman and also the local foreman of the terminal to which the engine is going. As soon as the engine arrives, the round-house foreman makes a close examination and prepares a statement which he sends to the master mechanic along with the engineman's written explanation. These various statements give the master mechanic full knowledge of the case, and he should have these papers within twenty-four hours after the failure occurred. In this, prompt action rests a large part of the value of an engine failure report for the division officers. It convinces everybody concerned that things are being watched and that indifference to the service will be treated accordingly.

The final ten-day or monthly statement of failures for the division is of value to both the operating and the mechanical departments. To the former, it should show the result of long hours on the road on both engine and engine crew as well as train crew, the result of inferior coal, poorly designed and operated coal stations, scanty and bad water supply, overloading of engines, indifferent train dispatching, lack of harmony in action on the part of the men in charge of a train.

To the mechanical department the report gives not only all this same information, but it also shows up poor design, weak parts, inferior material, bad shop practices, careless handling, indifferent inspection and poor workmanship. In order to fully indicate these defects the round-house foreman sends in with his personal examination report, a marked sketch of the defective part.

With a view to having uniformity in these reports and save time, the blank breakage report forms, printed in copying ink, as are shown in the last pages of the paper, are used. The local master mechanic and shop foreman first make use of these reports by inspecting the broken part, if necessary, investigating the matter of its preparation and application. They are then forwarded to the assistant superintendent of motive power and machinery, where they are again checked up and where, by the frequency of similar reports, attention is drawn to some particular defect. It may be some one design of cylinder head, rod strap, eccentric or strap, or any such part of the machinery of a certain class of engine is regularly giving trouble. These reports quickly show it up to those who have such matter in charge, and the detail is quietly and efficiently remedied without the necessity of any further investigtaion. Such would be the case if the shops are at all careless in preparing the detail and are passing as good enough parts that are not true as to dimensions, etc.

After the assistant superintendent is through with the reports they are sent to the mechanical engineer, who checks the dimensions of

the broken piece and makes use of the data obtained in designing new parts for old engines or preparing plans for new ones. If he finds that some one style of detail designed several years ago is not holding up under the present-day methods of operation, he takes steps to have it discarded as fast as possible and substitutes a modern design. He also strengthens a pattern here and re-arranges the metal there with a view to overcome external and internal defects that have been brought out by these reports.

As a further record and for the purpose of comparison, a monthly statement is prepared in the office of the superintendent of motive power and machinery, which classifies and details the failures and also shows totals for each division of the railway.

Form 806

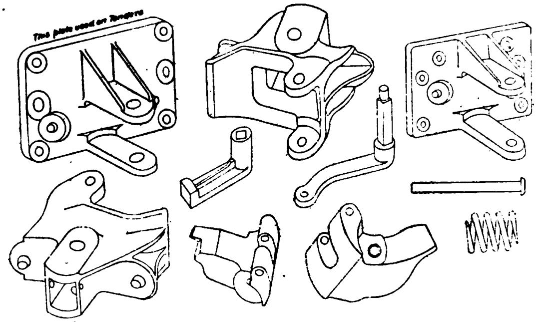
CHICAGO & NORTH WESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

PLATE COUPLER.

Engine No. ________ Date found on inspection ________ 190__
or
Class ________ Date of failure ________ 190__ Reported at ________

NOTE.—Indicate with red ink location of fracture and give dimension to some fixed point. Answer the questions below. Send report to Asst. Supt. M. P. & M., Chicago, Ill.



REMARKS.

Kind of metal.

Was there flaw at point of fracture?

Was there an old crack?

Probable cause of failure

________ Master Mechanic

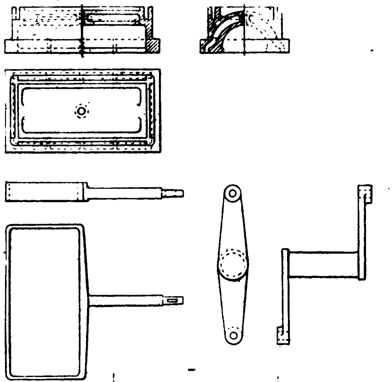
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS

VALVES, VALVE YOKES AND ROCKER SHAFT.

Engine No. ________ { Date found on inspection ________________ 190___
or
Class ________ { Date of failure ________________ 190___ Reported at ________________.

Note. Indicate with red ink location of fracture and give dimension to some fixed point. Answer the questions below. Send report to Asst. Supt. M. P. & M., Chicago, Ill.



VALVE	VALVE YOKE	ROCK SHAFT
Pattern No.	Kind of metal.	Pattern No.
Kind of Metal.	Dimensions and, if possible, sketch of section at point of fracture.	Kind of Metal.
Dimensions and, if possible, sketch of section at point of fracture.		Dimensions and, if possible, sketch of section at point of fracture.
Kind of valve.	Was there flaw at point of fracture	Was there flaw at point of fracture?
Kind of balancing.	Probable cause of failure?	Probable cause of failure?
Was there flaw at point of fracture?		
Probable cause of failure.		

________________ Master Mechanic.

Form 695

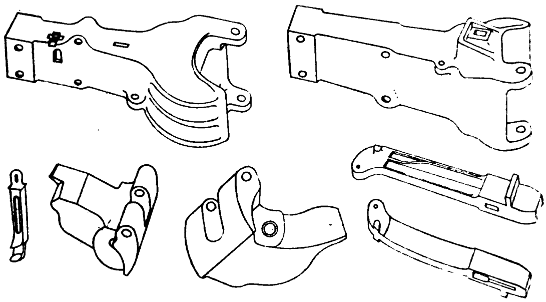
CHICAGO & NORTH WESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

PILOT COUPLER.

Engine No. ________ { Date found on inspection ________________ 190___
or
Class ________ { Date of failure ________________ 190___ Reported at ________________

Note. Indicate with red ink location of fracture and give dimension to some fixed point. Answer the questions below. Send report to Asst. Supt. M. P. & M., Chicago, Ill.



	REMARKS.
Kind of metal.	
Was there flaw at point of fracture?	
Was there an old crack?	
Probable cause of failure.	

________________ Master Mechanic.

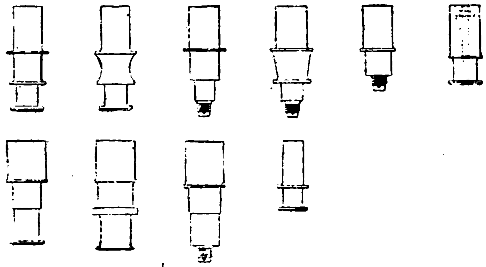
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

CRANK PINS.

Engine No. ______ { Date found on inspection ______ 190__
or
Class ______ { Date of failure ______ 190__ Reported at ______

NOTE.—Indicate with red ink location of fracture and give dimensions to some fixed point. Answer the questions below. Send report to Asst. Supt. M. P. & M., Chicago, Ill.



MAIN PIN.	BACK PIN.	FRONT PIN.
Dimensions and, if possible, sketch at point of fracture.	Dimensions and, if possible, sketch at point of fracture.	Dimensions and, if possible, sketch at point of fracture.
Kind of metal.	Kind of metal	Kind of metal
Was there flaw at point of fracture?	Was there flaw at point of fracture?	Was there flaw at point of fracture?
Was there an old crack?	Was there an old crack	Did it show an old crack?
Did fracture show crystallization?	Did fracture show crystallization?	Did it show crystallization?
About how long in service?	About how long in service?	About how long in service?
Probable cause of failure	Probable cause of failure	Probable cause of failure.

______ Master Mechanic.

Form [illegible] [illegible]

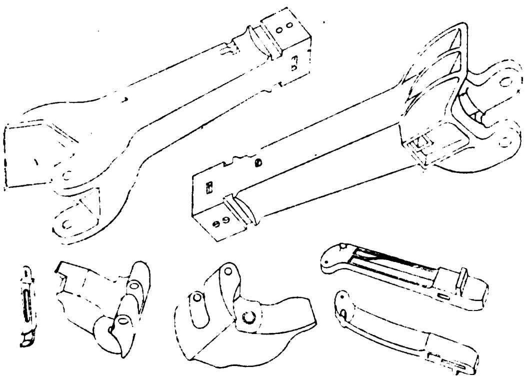
CHICAGO & NORTH WESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

M. C. B. COUPLER.

Engine No. ______ { Date found on inspection ______ 190__
or
Class ______ { Date of failure ______ 190 Reported at ______

NOTE.—Indicate with red ink location of fracture and give dimensions to some fixed point. Answer the questions below. Send report to Asst. Supt. M. P. & M., Chicago, Ill.



REMARKS

Kind of metal.

Was there flaw at point of fracture

Was there an old crack?

Probable cause of failure

______ Master Mechanic.

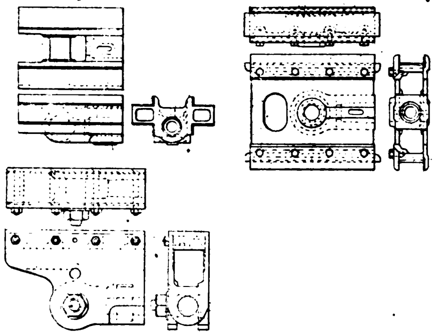
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

FOUR-BAR CROSSHEAD. LAIRD CROSSHEAD. TWO-BAR CROSSHEAD.

Engine Number, ______ Date of failure, ______ Reported at ______ 190

NOTE.—Indicate with red ink location of fracture, and give dimensions to some fixed point. Answer questions as below. Send report to Ass't Supt. M. P. & M., Chicago, Ill.



FOUR BAR CROSSHEAD	LAIRD CROSSHEAD	TWO BAR CROSSHEAD
Pattern No.	Pattern No.	Pattern No.
Kind of Metal.	Kind of metal.	Kind of Metal.
Dimensions and, if possible, sketch of section at point of fracture.	Dimensions and, if possible, sketch of section at point of fracture.	Dimensions and, if possible, sketch of section at point of fracture.
Was there flaw at point of fracture?	Was there flaw at point of fracture?	Was there flaw at point of fracture?
Probable cause of failure?	Probable cause of failure?	Probable cause of failure?

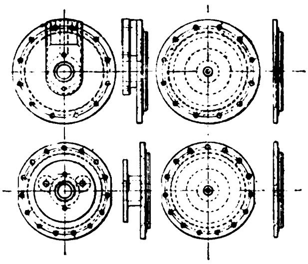
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS

CYLINDER HEADS.

Engine No. ______ { Date found on inspection ______ 190__
or
Class ______ { Date of failure ______ 190 . Reported at ______

NOTE.—Indicate with red ink location of fracture and give dimensions to some fixed point. Answer the questions below. Send report to Ass't Supt. M. P. & M., Chicago, Ill.



BACK HEAD.	FRONT HEAD.
Pattern No.	Pattern No.
Dimensions and, if possible, sketch of section at point of fracture.	Dimensions and, if possible, sketch of section at point of fracture.
Kind of metal.	Kind of metal.
Was there flaw at point of fracture?	Was there flaw at point of fracture?
Probable cause of failure.	Probable cause of failure.

Form 801

CHICAGO & NORTH WESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS NOT COVERED BY SPECIAL FORMS.

Engine No.________ Date found on inspection ____________190___
or
Class________ Date of failure ____________190____Reported at ____________

Hauling ____________ Section Train No.____________

REMARKS: ____

____

Master Mechanic.

NOTE.—Make sketches of one part only on a sheet, but as many views as may be necessary. Indicate with red ink location of fracture and give dimensions to some fixed point. Send Report to Assistant Superintendent Motive Power and Machinery, Chicago, Ill.

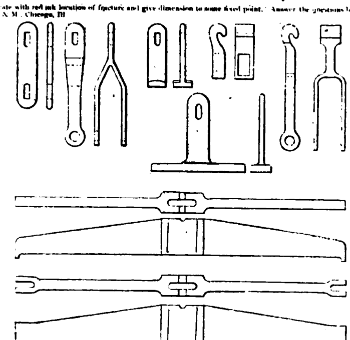
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

EQUALIZER. EQUALIZER STAND. SPRING HANGERS

Engine No.________ Date found on inspection ____________190
or
Class ________ Date of failure ____________190 Reported at ____________

NOTE.—Indicate with red ink location of fracture and give dimension to some fixed point. Answer the questions below. Send report Asst. Supt. M. P. & M., Chicago, Ill.



EQUALIZER.	EQUALIZER STAND.	SPRING HANGERS
Dimension and, if possible, sketch of section at point of fracture	Dimension and, if possible, sketch of section at point of fracture.	Dimension and, if possible, sketch of section at point of fracture
Kind of metal.	Kind of metal	Kind of metal.
Was there flaw at point of fracture	Was there flaw at point of fracture?	Was there flaw at point of fracture?
Probable cause of failure	Probable cause of failure.	Probable cause of failure

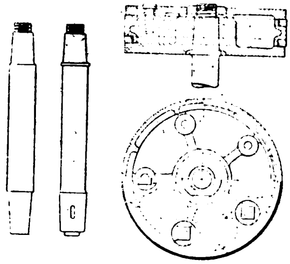
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS

PISTON AND PISTON RODS

Engine No. ________ Date found on inspection ________ 190__

Date of failure ________ 190__ Reported at ________



PISTON	PISTON FOLLOWER	PISTON ROD
Follower ring, Spider	Pattern No.	
Dimensions and if possible sketch	Dimensions and if possible sketch at point of fracture	Dimensions and if possible sketch at point of fracture
Kind of packing		Kind of metal
		Was there flaw at point of fracture?
Back packing ring	Kind of metal.	Did it show any old crack
	Was there blow hole or flaw at point of fracture?	Shop letter and date put in
Probable cause of failure	Probable cause of failure	Probable cause of failure.

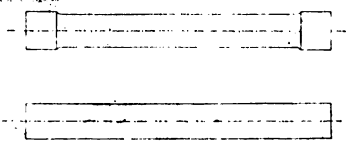
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS

AXLE

Engine Number ________ Date of failure ________ Reported at ________ 190__

Send report to



Dimensions and if possible sketch of section at point of fracture

Kind of metal

Was the metal homogeneous?

Did it show crystallization?

Was there flaw at point of fracture?

Probable cause of failure

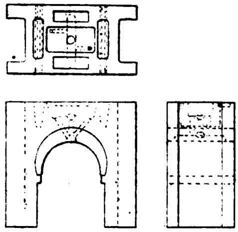
CHICAGO & NORTHWESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

DRIVING BOX AND BRASS.

Engine Number________ Date of failure________________ Reported at ________________

NOTE.—Indicate with red ink location of fracture, and give dimensions to some fixed point. Answer questions as below. Send report to Ass't Supt. M. P. & M., Chicago, Ill.



BOX | BRASS

Pattern No. | Pattern No.

Dimension and, if possible sketch of section at point of fracture | Dimension and if possible sketch of section at point of fracture

Was it front, back or middle | Was it front, back or middle

Kind of metal | Kind of metal

Was there flaw at point of fracture? | Was there flaw at point of fracture?

Probable cause of failure | Probable cause of failure.

CHICAGO & NORTH WESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS

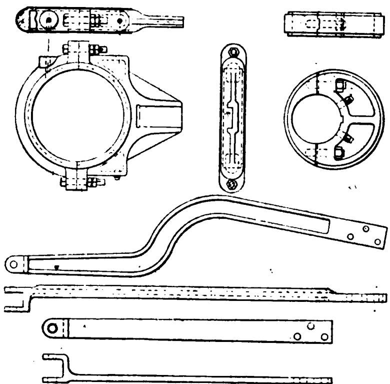
ECCENTRIC, ECCENTRIC STRAP, ECCENTRIC ROD

Engine No. ________ { Date found on inspection________________190..

or

Class________ { Date of failure________________190__ Reported at________________

NOTE.—Indicate with red ink location of fracture and give dimension to some fixed point. Answer the questions below. Send report to Ass't Supt. M. P. & M., Chicago, Ill.



ECCENTRIC	ECCENTRIC STRAP	ECCENTRIC ROD
Pattern No.	Pattern No.	Dimensions, and if possible sketch of section at point of fracture
Forward______Back______	Forward______Back______	
Dimension, and if possible, sketch of section at point of fracture.	Dimension, and if possible, sketch of section at point of fracture.	
Kind of metal.	Kind of metal	Kind of metal
Was there flaw at point of fracture?	Was there flaw at point of fracture?	Was there flaw at point of fracture?
Probable cause of failure	Probable cause of failure	Probable cause of failure

____

Master Mechanic

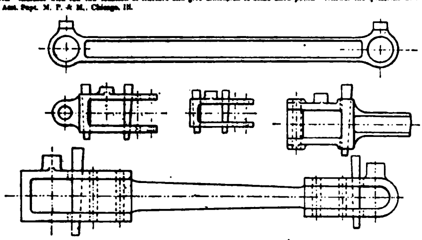
CHICAGO & NORTH WESTERN RAILWAY CO.

REPORT OF BREAKAGES OF LOCOMOTIVE PARTS.

SIDE ROD, MAIN ROD AND ROD STRAP.

Engine No.______ Date found on inspection______190__
or
Class______ Date of failure______190__ Reported at______

Note.—Indicate with red ink location of fracture and give dimension to some fixed point. Answer the questions below. Send report to Asst. Supt. M. P. & M., Chicago, Ill.



SIDE ROD.	MAIN ROD.	ROD STRAP.
Front end,	Dimensions and, if possible, sketch of section at point of fracture.	Front strap,
Back end,		Back strap.
Dimensions and, if possible, sketch of section at point of fracture		Dimensions and, if possible, sketch of section at point of fracture.
Kind of Metal.	Kind of Metal.	Kind of Metal.
Was there flaw at point of fracture?	Was there flaw at point of fracture?	Was there flaw at point of fracture?
Probable cause of failure.	Probable cause of failure.	Probable cause of failure.

President Bentley: Before the discussion is opened, the Secretary has a few letters here giving some written discussion on the subject; we will be glad to have him read them.

The Secretary: I sent out copies of this paper to certain superintendents of Motive Power and Master Mechanics and asked them if they would not, at least, furnish us with their records or their forms; in some cases I have received those and also some little discussion of the paper.

W. H. Wilson (S. M. P., B. R. & P. Ry.): We have no rules in effect for making records of engine failures. We have, however, a set of rules that if occasion demands we expect to put in effect, a copy of which I hand you.

My experience so far on this property has been that a fixed set of rules is not necessary. The Mechanical Department accepts, without serious question, the reports of the dispatchers on engine failures, believing that considerable time and friction is avoided by not debating with the Transportation department whether their reports are just or not. The reports are carefully gone over, however, by myself and staff, and if faulty design, shop, or round house practice or neglect, is shown by the reports the matter is taken in hand at once. We stand for an engine failure caused by poor coal,

by tired out engine crews and over-worked engines after being on duty over the usual time.

Consequential delays to other trains caused by an engine failure are also shown on our engine failure report, a copy of which I enclose.

BUFFALO, ROCHESTER & PITTSBURGH RAILWAY COMPANY

....................**Division.**

....................................190...

Mr. W. T. Noonan, General Manager.

Dear Sir: Report of engine failures for 24 hours ending 6:00 a. m. ....190...

Trn.	Eng.	Eng'man	Location	Nature of Failure and Cause of Same

Copy to..............................

..............................Superintendent.

BUFFALO, ROCHESTER & PITTSBURGH RY. CO.

Mechanical Department.

RULES GOVERNING REPORTS OF ENGINE FAILURES.

No. 1. A delay of more than two minutes to a passenger train or more than five minutes to a freight train, caused by any defects in the engine or tender, will be an engine failure. Time made up after a failure occurs not exceeding two minutes for a passenger train or five minutes for a freight train, will cancel that failure. Time made up after a failure exceeding two minutes for a passenger train and five minutes for a freight train, will not cancel failure, but the amount made up must be shown on engine failure report, Form 512. Show the same engine once only on form 512 for failures on the same train, but specify all causes of failure.

No. 2. Reports must be accurate and intelligible. No indefinite reports, such as "engine not steaming," "hard pulling train," and "engine not working good," will be accepted.

No. 3. Engineers running over more than one division with the same engine and train will not be charged with more than one failure on account of same defect.

No. 4. Consequential delays to other trains, caused by an engine failure, will be shown on engine failure report, form 512.

The following delays will not be considered or accepted as engine failures:

No. 1. Delays to trains in terminal yards, on account of work not being completed in time on the engine which is ordered to take train through to the next terminal.

No. 2. Anything occurring to an engine before it leaves the turntable, or after it leaves its train at the terminal.

No. 3. Delays due to accidents or derailments of which the engine or tender is not the primary cause.

No. 4. Breakages, derailments or delays caused by engines striking obstructions on or beside the track.

No. 5. Delays to switch engines caused by necessary repairs, fire cleaning, taking coal, water or sanding at the end of its day's work.

No. 6. Delays due to taking coal, water or sand at regular stations, or on account of heavy trains, bad rails or long hours on the road.

No. 7. Delays due to brakes sticking on train when not caused by any defects on the engine.

No. 8. Delays due to lack of coal or water when caused by engine being held out on the road an unreasonable length of time.

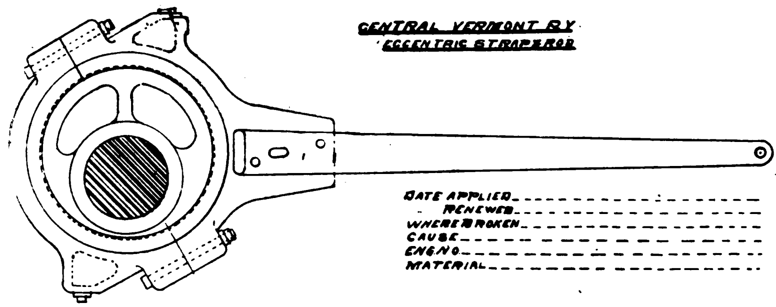
No. 9. Delays due to an engine slipping, stalling or reducing tonnage on account of bad weather, wind, snow, cold or foreign substance on rails.

No. 10. Broken draft gear on either engine or tender, when caused by train parting, or airbrakes being otherwise improperly set on the train.

No. 11. Work done on engines while waiting for orders, or for passing trains, or while station work is being done.

No. 12. Engines going to shop for repairs coupled in or dead in train. But if handling train alone whether it pulls full tonnage or not, they will be treated the same as other engines.

A. Buchanan, Jr., (S. M. P. Central Vermont, R. R.): The question of engine failures to my mind, is an important one. I attach hereto diagram showing form that we use on this road for reporting failures. This form is made out by Foreman at whose terminal the engine is assigned. He fills out in detail the information called for on both sides of the form.



We consider an engine failure any detention, reduction of tonnage, or giving up of train on account of defects in the locomotive. We do not consider it an engine failure where fuel only is responsible. We attempt after each failure to locate the responsibility taking it for granted that practically all failures are avoidable by proper inspection and maintenance by either the enginemen handling the

engine or the locomotive force at the engine house. There are few failures, in my opinion, which cannot be avoided if proper inspection is given to the manufacture, application, and maintenance of material.

T. S. Lloyd, (Genl S. M. P., C. R. I. & P. Ry.): I enclose herewith copy of the blanks used for engine failures on this system and would advise that the instructions are that all detentions due to engine, exceeding five minutes must be noted as engine failures, regardless of whether or not the engine afterward makes up time lost.

CHICAGO, ROCK ISLAND & PACIFIC.
Motive Power Department.

..................................190...

To...

Engine No..........Train No..........Date....................190...
Time called to leave......M. Departed from..................at....M.
Arrived at...............M. Arrived at Round House Track at.......M.
Engineers will fill out one of these forms for all delays to their train.
Departed Late....Hrs.....Mins. Arrived Late....Hrs.....Mins.

Place Delayed	Time Delayed	State Cause of Delay at Each Point.
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

Sign..............................Engineer.

ROCK ISLAND LINES.

.... **Division.**

Report of Broken ....
Engine or Car No.........; Class........; Date........; Train........
Name of Engineman,....................; Place.....................
Cause...
State if starting; or, if stopping, whether brakes were applied,..........
.....................; Was engine using steam?.......................
Speed of Train, in miles, per hour,....Grade, ascending or descending....
Length of detention to train due to Breakage.........................

Sketch of Broken Part.

Note—Give casting number if cast iron, steel or other metal, also dimensions of fracture and its location with reference to some fixed point. Report also other breakages of machinery, cars, etc., on this blank.

....
....
....
....
....
....

Remarks: ....
....

Signature,.........................
....

ROCK ISLAND SYSTEM.

Chicago, Ill.

Statement showing engine failures for 24 hours ending 190

Division	Engine No.	Train No.	Time Lost Hrs.	Time Lost Min.	Cause of Failure

C. R. I. & P. RY.

RECORD OF FAILURES OF ENGINEMEN.

1904	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total
January,																																
February,																																
March,																																
April																																
May,																																
June,																																
July,																																
August,																																
September,																																
October,																																
November,																																
December,																																

C. R. I. & P. RY.

STATEMENT OF ENGINE FAILURES.

A ____________________ *DIVISION.*

To { *Gen'l Supt. Transportation,* *Supt. Motive Power,* *General Superintendent.* } ____________ *B* ____________ 190__

Following is report of Engine Failures and Causes for 24 Hours ending 6 o'clock this A. M.

	Engine	Train	Engineer	Time at Terminals before Starting Hrs.	Min.	Place	Hour Left Terminal	Failure Reported Time	Place	Time Lost Hrs.	Min.	Miles Made	Cause of Failure	Remarks

REMARKS ____________________

C. R. I. & P. RY.

Record of Locomotive Failures for the Month of ....190........ Chargeable to ....Division.

INSTRUCTIONS.—Make each entry in form of a fraction, the numerator showing character of failure—1, Heating; 2, Steam; 3, Leaking; 4, Broken; 5, Other. The denominator showing the engine house from which the locomotive started. Use red ink for failure in Passenger Service.

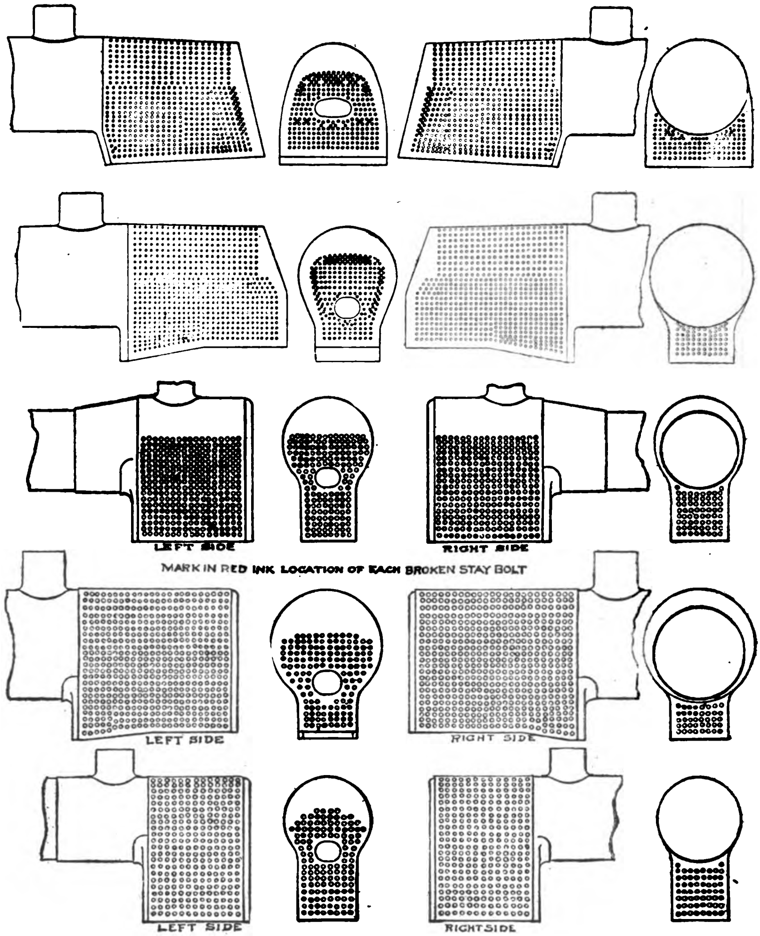
DATE / LOCOMOTIVE	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total	Total Last Month
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Total	Last Month
Total																																	
Total Last Month																																	

C. R. I. & P. RY.

Report of Stay Bolts and Interior Examination of Boiler

Of Engine No.______________ at ______________________________ Station

______________________ 190___, Examined by______________________________



The interior of all Boilers must be carefully examined by a competent Inspector or Boiler Foreman whenever the Flues are taken out, and the condition of all Braces, Crow Feet, Seams, etc., as they were found, noted on the lines opposite the printed names of the parts, mentioning also the repairs that were made to same before putting the engine into service.

____

Respectfully submitted,

____
M. M. or G. F.

G. S. McKee (S. M. P. & C. E., M. & O. R. R.): Our practice of charging engine failures is that we only charge such failures for which the engines are directly responsible, such as broken parts of machinery, boilers leaking, steam failures and hot bearings.

John Tonge (M. M., Minn. & St. Louis R. R.): The subject of engine failures is an important one but it always appeared to me that railroad managers never "took the bull by the horns" properly, in order to prevent engine failures, and what I term the "bull" is the train dispatcher or "chief" if you please.

A General Manager or a General Superintendent may issue instructions to their subordinates, giving the same deep consideration, but when these instructions are left to the judgment of a dispatcher, it rarely ever occurs that the consideration given by the higher officials is considered, because it must be taken for granted no higher official desires to lose money in the operation of his road. The train dispatcher, strictly speaking, is the man through whom proper returns can be had or not had.

For many years I have taken the position, and I still believe it is the only position for a railroad manager to take,—that all dispatchers should be compelled to have as thorough knowledge of the proper care of an engine and of firing an engine as an engineer or fireman and if such were the case, we would have reason to expect fewer engine failures, because it would be plain to him that from his examination his superior officers would have reason to tell him that he knew better than to do this or that, which tends to engine failures.

I consider it the keynote upon which we should hang and hang tightly as motive power managers, insist upon our general officers that dispatchers be not employed unless they thoroughly understand how to care for a locomotive.

Wm. McIntosh, (S. M. P., C. R. R. of N. J.): There are as many different methods of recording engine failures as there are railroads, and about as much uniformity in results as there is in locomotive performance sheets as variously compiled.

The plan followed on the North-Western Road, as explained by Mr. Dunham, appears to be as fair and liberal as could be desired, due allowance being made for time made up and for delays resulting from causes beyond the control of the Motive Power Department. I do not see that Mr. Dunham's list makes any allowance for poor coal. Possibly such an exception would be too indefinite and lead to contention; or it may be his road furnishes a uniform grade of coal, always of good quality. This would be the exception, however, as there are usually some wide variations in the quality of coal on the majority of roads; some grades being of such poor quality that no locomotive could steam with it.

On the road with which I am connected we follow up engine delays to a finish, each report being traced until the facts are known; all delays of one minute or more being recorded, and no allowance

being made for making up time or reaching destination on time; the delay or failure once occurring, can not be eradicated. In addition to a ledger record of each failure established, we have the graphic or diagramatic report similar to the North-Western, which is indispensable, enabling, as it does, the Mechanical Engineer to locate weak points in the engine design. A few failures of any part of the machine in the same place points to a defect that needs immediate attention, frequently calling for radical treatment.

While engine failures may be classed among the disagreeable features of railroading, they are like the poor—always with us, and a complete record enables those in charge of designing and maintaining motive power to follow it up from day to day and gather the information necessary to reinforce weak parts and overcome the difficulties promptly as they develop.

I submit a leaf from our ledger, showing method of recording failures, and a blue-print of monthly report of failures. The number of engines relieved may appear large, but with such dense traffic as exists in the four-track and terminal districts an engine that fails in maximum efficiency is relieved at the first opportunity, and such opportunities are available at frequent intervals.

Engine Failures for Month of October, 1906.

Classification	Divisions			Total
	NJC	NJS	L&S	
Brake Mechanism:				
Air pump reversing stem broken			1	1
Air pump discharge valve stuck			1	1
Air pump piston head, air end, loose			1	1
Air pump piston valve ring broken		1		1
Air pump reversing plate bolt worked out			1	1
Air pump reversing valve broken	1			1
Air hose between engine and tender broken	2			2
Engine truck brake beam broken	1			1
Tender train line leaking	2			2
Air pump throttle union nut bursted	1			1
Main reservoir air pipe broken	1			1
Engine truck brake adjusting rod bolt out	1			1
Total	9	1	4	14
Grates and Ashpans:				
Drop grate down	1			1
Total	1	0	0	1
Broken and Defective Bolts:				
Side rod strap bolt broken		1		1
Eccentric strap bolt broken			2	2
Spring hanger bolt broken	2		1	3

Classification	Divisions NJC	NJS	L&S	Total
Eccentric rod bolt lost	1			1
Link bolt cotter broken—nut came off	1			1
Main rod strap bolt broken		1		1
Total	4	2	3	9
Heated Bearings:				
Driving box hot	6		5	11
Tender box hot	7		3	10
Engine truck box hot	1			1
Totals	14	0	8	22
Lack of Steam:				
Poor coal	12	5	7	24
Poor fire starting on run			2	2
Flues blocked			1	1
Coal wet—tank rivet out			1	1
Inattention of fireman	3			3
Hurry call for power	2			2
Engine foaming	1			1
No hard coal	1			1
Draft pipe too low	2			2
New fireman	2			2
Blower pipe broken	1			1
Total	24	5	11	40
Steam Leakages:				
Flues leaking	7	5	7	19
Firebox side seams leaking		1	1	2
Relief valve blown out	1			1
Throttle leaking	1			1
Total	9	6	8	23
Injector Failures:				
Boiler check stuck			1	1
Total	0	0	1	1
Miscellaneous breakages:				
Driving spring broken	1		1	2
Throttle quadrant broken			1	1
Sand pipe broken			1	1
Piston rod broken	1		1	2
Transmission rod hanger casting broken			2	2
Main rod bent and cylinder head broken			1	1
Eccentric strap broken	1		1	2
Tender coupler broken	4		1	5
Tender journal broken	1		1	2
Transmission rod broken	1			1
Guides and piston rod bent and guide blocks broken	1			1
Steam pipe broken	1			1
Tender wheel flange broken	1			1

Classification	Divisions NJC	NJS	L&S	Total
Steam chest broken	1			1
Driving spring hanger broken	1	2		3
Lubricator glass broken	1			1
Drawbar between engine and tender broken	1			1
Eccentric rod broken	1			1
Rocker arm pin broken	1			1
Link hanger broken	1			1
Tumbling shaft arm broken	1			1
Main rod key broken	1			1
Engine truck equalizer broken	1			1
Total	22	2	10	34
Other Causes:				
Engine too small for run—used in emergency		1		1
Cylinder cock blocked			1	1
Engine surged—coupler opened several times			1	1
Equalizer spring slipped out of hanger			2	2
Side rod oil cup thread stripped			1	1
Coupler pin bent	1			1
Headlight out—poor oil	2			2
Steam hose on engine blocked	1			1
Side rod knuckle pin loose	1			1
Eccentric slipped	1			1
Coupler knuckle lock defective—too much lost motion—uncoupled	1			1
Main rod keyed too tight	1			1
Pilot burnt slightly	1			1
No sand	1			1
Driving tire worked off	1			1
Flue bursted	1			1
Total	12	1	5	18
Grand Totals	95	17	50	162
Engine mileage—each division......696,261	91,828	350,981		1,139,070
Miles run per failure......7,329	5,401	7,020		7,031

Engines Gave Up Train.

Cause of Failure.	Divisions NJC	NJS	L&S	Total
Flues leaking	3	1		4
Injector boiler check stuck			1	1
Driving box hot	1		1	2
Throttle quadrant broken			1	1
Equalizer spring slipped out of hanger			1	1
Piston rod broken	1		1	2
Transmission rod hanger casting broken			2	2
Tender box hot			1	1
Main rod bent and cylinder head broken			1	1

Cause of Failure.	Divisions NJC	NJS	L&S	Total
Air pump reversing plate bolt worked out.			1	1
Eccentric strap bolts broken............			1	1
Eccentric strap broken................			1	1
Tender coupler lug broken..............	1		1	2
Transmission rod broken...............	1			1
Steam pipe broken....................	1			1
Tender wheel flange broken............	1			1
Steam chest broken...................	1			1
Throttle leaking	1			1
Side rod knuckle pin loose.............	1			1
Driving spring broken..................	1			1
Rocker arm pin broken................	1			1
Main tire worked off..................	1			1
Flue bursted	1			1
Blower pipe broken....................	1			1
Tender journal broken.................	1			1
Firebox side seams leaking.............		1		1
Tumbling shaft arm broken.............	1			1
Totals	19	2	13	34

Summary of Engine Failures, October, 1906.

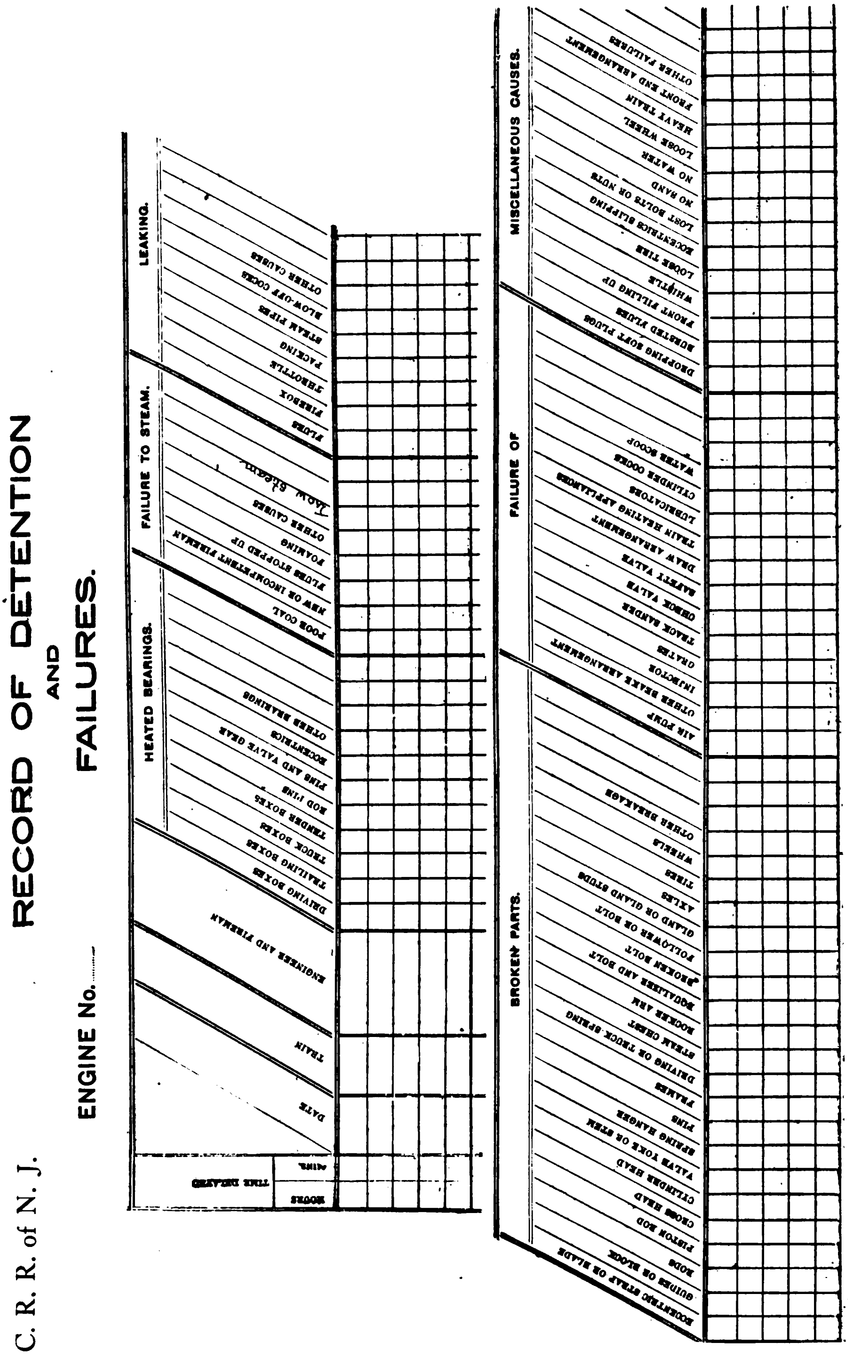
Nature of Failure	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Brake mechanism..	11	22	20	8	5	8	10	15	8	14			
Grates and ashpans	1	4	7	2	1	4	0	2	3	1			
Bro. and Def. bolts	4	5	10	2	4	9	8	1	6	9			
Heated bearings...	36	31	34	21	56	40	35	32	35	22			
Lack of steam.....	41	70	51	10	11	26	23	37	53	40			
Steam leakages....	16	25	24	7	16	11	14	23	28	23			
Injector failures....	4	9	5	2	3	9	5	6	0	1			
Tank Fix. defects..	3	3	2	0	0	0	0	2	2	0			
Miscel. breakages..	34	36	53	25	32	40	38	29	38	34			
Other causes......	18	18	22	9	14	12	17	17	17	18			
Totals	168	223	228	86	142	159	150	164	190	162			
Gave up train.......	34	42	53	19	44	48	41	48	50	34			

Approved,

....

Office of Mechanical Engineer,
Jersey City, N. J.

Supt. M. P.


C. R. R. of N. J.
RECORD OF DETENTION AND FAILURES.
ENGINE No.........
TIME DELAYED
HOURS
MINS.
DATE
TRAIN
ENGINEER AND FIREMAN
HEATED BEARINGS.
DRIVING BOXES
TRAILING BOXES
TRUCK BOXES
TENDER BOXES
ROD PINS
PINS AND VALVE GEAR
ECCENTRICS
OTHER BEARINGS
FAILURE TO STEAM.
POOR COAL
RAW OR INCOMPETENT FIREMAN
FLUES STOPPED UP
FOAMING
OTHER CAUSES
LEAKING.
FLUES
FIREBOX
THROTTLE
PACKING
STEAM PIPES
BLOW-OFF COCKS
OTHER CAUSES
BROKEN PARTS.
ECCENTRIC STRAP OR BLADE
GUIDES OR BLOCK
RODS
PISTON ROD
CROSS HEAD
CYLINDER HEAD
VALVE YOKE OR STEM
SPRING HANGER
PINS
FRAMES
DRIVING OR TRUCK SPRING
STEAM CHEST
ROCKER ARM
EQUALIZER AND BOLT
BROKEN BOLT
FOLLOWER OR BOLT
GLAND OR GLAND STUDS
AXLES
TIRES
WHEELS
OTHER BREAKAGES
FAILURE OF
AIR PUMP
OTHER BRAKE ARRANGEMENT
INJECTOR
GRATES
TRACK SANDER
CHECK VALVE
SAFETY VALVE
DRAW ARRANGEMENT
TRAIN HEATING APPLIANCES
LUBRICATORS
CYLINDER COCKS
WATER SCOOP
MISCELLANEOUS CAUSES.
DROPPING SOFT PLUGS
BURSTED FLUES
FRONT FILLING UP
WHISTLE
LOOSE TIRE
ECCENTRIC SLIPPING
LOST BOLTS OR NUTS
NO SAND
NO WATER
LOOSE WHEEL
HEAVY TRAIN
FRONT END ARRANGEMENT
OTHER FAILURES

W. O. Moody (Mechanical Engineer, Illinois Central Railroad): The engine failures with the method followed by the man who is responsible for getting his engine or engine and train from the main line in the minimum amount of time is an education to others, who may have to face similar conditions, and brings out those qualities which may in the future, because of resourcefulness in emergencies, cause their selection to oversee and instruct their fellows.

Seemingly an engine inspector should have a previous training, either in shop or on the road, or be put through some sort of an examination to determine his fitness for the position, because much depends upon the thoroughness and intelligence of his examination.

His road experience gives him a knowledge enabling him to locate the probable sources of future trouble and to bestow upon these parts a more searching examination and with a greater degree of intelligence.

A more rigid and thorough examination of engines while housed would probably result in increased work for the round-house force in order to promptly and properly care for defects discovered.

Efficient engine repairs can be traced to proper entries made on the work book, such entries as "injector would not lift" or "lubricator not working" leaves much in the hands of the machinist delegated for the work, and entails much additional time to locate the trouble before proceeding to rectify it.

When men have regularly assigned engines, the personal element occasionally manifests itself in work report books. Sometimes a man will report the right cylinder loose on one side, to insure that the engine will not be held over for work, when as a matter of fact both cylinders were loose, and the next trip in, the left side is reported. By this scheme he is sure of going out on his regular engine, to which by long familiarity he had become attached.

It is understood that defects, such as concealed flaws in materials, may exist, even when engines are under construction at the builders, which no amount of inspection will reveal.

Improperly fitted cross-head keys may produce a failure, unless the work is inspected during its progress from vise to engine, which is another phase of the inspection proposition. But this and many other causes for future trouble may be elimited by a systematic method of inspection by a corps of trained and conscientious inspectors.

Geo. W. West (S. M. P., N. Y. O. & W. Ry): I hand you herewith the only form of engine failure reports which we have on this road. These blanks are filled in by the engineer and sent to this office daily and I am able to examine them, and any failures of engine or cars are noted in a book, sample pages also enclosed, and we are then able to see by days, months or years what particular part of the engine is causing delays and also the defects in the car equipment, both passenger and freight, that are giving us trouble.

Form M. P. 32

New York, Ontario & Western R'y Co.

DETENTION REPORT FOR

Eng. No.................................... Date.............................. 190....

Train No.................................... Kind of Train..............................

From.................................... To..............................

Dep. Time.................................... Arr. Time..............................

No. Empty Cars..

No. Loaded Cars..

HRS.	MIN.	STA.	DETENTIONS
......	......	....	....
......	......	....	....
......	......	....	....
......	......	....	....
......	......	....	....

....Engineeman

NOTE—Enginemen must report all detentions, etc., on this form and send it to Round House with the engine at the end of each trip, and give cause of detention. If from hot box state cause of box heating.

N. Y., ONTARIO & WESTERN RY. CO.

ENGINE FAILURES.

CAUSE	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.
....	......	......	......	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......	......	......	......

New York, Ontario & Western Ry. Co.

Freight. **CAR FAILURES.** **January, 1906.**

Hot Box				Air Inspection				Train Parted				Coupler Failures				Brake Failures							
Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

(OBVERSE)

Passenger. **CAR FAILURES.** **January, 1906.**

Hot Box				Steam Heat Failure				Air Brake Failures				Coupler Failures											
Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern	Train	Southern	Scranton	Northern
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....
....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....	....

(REVERSE)

J. F. WALSH (S. M. P., C. & O. Ry.): We send you herewith copy of blank which we use for having our engineers report engine failures. It will explain itself.

CHESAPEAKE AND OHIO RAILWAY COMPANY.
Engineman's Report of Delays, Account of Engine Failure.

Engine No. .....Train No.	Location ....
Engineman	Date ....
Fireman	Time ....
Conductor	On Time or Late...Hours...Min.

Cause and Nature of Failure.

....
....
....
....
....
....
....

Station ....

..............................Engineman.

Date ....

Engineman must fill out this form neatly and carefully with full explanation of the cause of failure, and deliver to the Division Master Mechanic or General Foreman UPON ARRIVAL AT DESTINATION.

(OBVERSE)

Chespeake and Ohio Railway Co. **Engineman's Report of Delays, Account of Engine Failure** Location .... Engine No. ......Train No. ...... Date .... 190.. .... Master Mechanic or General Foreman will either confirm Engineman's Report or make satisfactory explanation of same, and forward promptly to the Superintendent of Motive Power for file in his office.	**Remarks By Master Mechanic or General Foreman** ....

(REVERSE)

L. R. JOHNSON (Asst. S. M. P. Can Pac. Ry.): Your letter of the 8th, has only just reached me, and in order to get the forms to you for reporting engine failures, we shall have to send them right away by this mail, consequently I am afraid I shall not be able to send you anything in the way of criticism.

(20-4-05-1000)

CANADIAN PACIFIC RAILWAY COMPANY

LINES EAST

MOTIVE POWER DEPARTMENT

STATEMENT OF ENGINE FAILURES

CAUSE OF FAILURE		ATLANTIC DIVISION				EASTERN DIVISION				ONTARIO DIVISION				LAKE SUP. DIVISION			
		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT	
		No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost
MISCELLANEOUS																	
Waiting for Engine	MP																
" " "	T																
Trains too Heavy	T																
Slippery Rails	T																
High Wind	T																
Fireman	T																
Fuel	T																
Headlights	MP																
"	T																
Flues	MP																
"	T																
Ashpans	MP																
" "	T																
Draft Rigging	MP																
" "	T																
Springs	T																
"	MP																
Grates	MP																
"	T																
BOILER FAILURES																	
Boiler Defects	MP																
Diaphragm and Nettings	MP																
Steam Pipes	MP																
HOT BEARINGS																	
Boxes, Driving	MP																
" Truck	MP																
" Tender	MP																
Crank Pins	MP																
MACHINERY FAILURES																	
Arms, Rocker	MP																
Axles, Driving	MP																

CAUSE OF FAILURE		ATLANTIC DIVISION				EASTERN DIVISION				ONTARIO DIVISION				LAKE SUP. DIVISION			
		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT	
		No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost
Axles Truck	MP																
" Tender	MP																
Boiler Mountings	MP																
Cylinders	MP																
Cylinder Head and Cover	MP																
Compound Gear	MP																
Crosshead	MP																
Crank Pins	MP																
Eccentrics	MP																
Frame and attachments	MP																
Guides	MP																
Injectors	MP																
Intercept'g Valves & Rigging	MP																
Link Motion and Details	MP																
Pistons and Rods	MP																
Rods, Main	MP																
" Side	MP																
Reversing Gear	MP																
Spring Rigging	MP																
Sanding Apparatus	MP																
Steam Heat	MP																
Steam Chest and Heads	MP																
Throttle Rigging	MP																
Tyre, Driving	MP																
" Engine and Tender	MP																
Valves	MP																
Valves, Stems and Buckle	MP																
Wheels	MP																
Packing	MP																
AIR BRAKE FAILURES																	
Air Brake Apparatus	MP																
" Signal "	MP																

SUMMARY

DIVISIONS		MISCELLANEOUS								BOILER FAILURES				HOT BEARINGS				MACHINERY FAILURES				AIR BRAKE FAILURES				ALL FAILURES							
		MOTIVE POWER				TRANSPORTATION																				MOTIVE POWER				TRANSPORTATION			
		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT		PASSENGER		FREIGHT	
		No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost	No.	Time Lost
ATLANTIC	190																																
	190																																
EASTERN	190																																
	190																																
ONTARIO	190																																
	190																																
L. SUPR.	190																																
	190																																
ALL	190																																
	190																																

CANADIAN PACIFIC RAILWAY COMPANY.

Mechanical Department

Report of Cracked Driving Wheels.

This form to be returned by Loco. Foreman to M. M. at end of each month.

Engine No.........Station,............Month ending............190...

No. of Spokes in Wheel.......
No. of Spokes Broken.........
No. of Spokes Cracked........
No. of Cracks in Rim.........

Cracks in Wheel Hub and Crank Hub.
To be Sketched in Position.
Length of Crack in Hub.........

Remarks ....
....
....
....
....
....
....

(Diagram of Wheel on which to Sketch Broken Part.)

....Loco. Foreman.

President Bentley: Gentlemen, you have heard the written discussion on this very important subject. I thought it was rather unfortunate that the original plan we had outlined last month of having the discussion on "Train Dispatchers" and "Engine Failures" on the same evening could not be carried out, but as it happens, it turned out to be rather wise, otherwise there might have been serious recriminations. I understand, however, that the train dispatchers' meeting was a very interesting one; I was very sorry I could not be here. Seeing that the train dispatcher has been spoken of so disparagingly, I think it would be very nice if we could hear from a train dispatcher if there is one in the room and see what he has to say about the engine failures that cause him so much trouble. If there is anybody here who has held an official position in dispatching trains, we would be very glad to hear from him.

Mr. H. C. Hope (Supt. Telegraph, C. St. P. M. & O. Ry.): I was a visitor here a month ago. I am not a train dispatcher, but had the pleasure of listening to the very able paper as read by Mr. Mackie and the discussion. I am here today on a Telegraph Superintendents' committee meeting and was invited by some of your members to attend this meeting tonight.

What I wish to say is that several weeks ago the management of our railroad was out on an inspection tour; our General Manager having been former Superintendent of the division where we laid up for the night. We spent some time at the division headquarters, checking up train sheets and visiting with the train dispatchers and trainmen and several engineers.

By having a meeting of this kind with the Division Superintend-

ent and his assistants, we found there were two sides; in some cases the train dispatchers were not using the good judgment they should. Also the engineers were sending back word to the round house foreman that they were sick and other reasons. These matters have been gone into by our officials and we think the engineer and the dispatcher will become more interested in each other for the good of the service.

PRESIDENT BENTLEY: Gentlemen, let us know how to overcome the trouble. There is no doubt, if the train dispatcher and engine department do not work in harmony, the engine failures will keep growing. A great deal of dissatisfaction exists, but there are two sides to this question, and I always try to get in close touch with the other department if possible. The way I would like to feel about these things is that the mechanical department makes a great many mistakes and the other department sometimes is not "behind the bush" in telling us about it. I feel this way, that we absolutely must make some mistakes if we do anything, but when we do make mistakes, when we have trouble of that sort, let us own up and say it was our fault. We cannot be perfect, but I would like to see the train dispatchers, if they make a mistake, be as free to tell us that the trouble is theirs and not with the engine.

MR. W. G. WALLACE: Some years ago it was my pleasure to serve a railway officer who informed me that he desired excuses for trains being on time rather than an excuse for their being late. His advancement to more responsible positions is an indication that his aim was in the right direction

An engine failure report is simply an excuse or explanation of the delay to the train to which it is attached and to others which it affects. The author of the paper has brought out many points that are worthy of consideration by all departments of the railway.

On page 2 the question is asked: "When a train dispatcher has worked an engine between outlying points until it is unfit for service and then endeavored to send her to the shop terminal with full tonnage that she is not able to handle, is that an engine failure? In answer to that question it would seem proper that it should be termed a "man"-failure and one that properly belongs to the operating department and the train dispatcher, instead of to the mechanical department.

An engine that is not capable of handling the train tonnage of her class is known as a "weak sister," and the train dispatcher cannot afford to tie up the first class power by laying it out in order to insure the inferior engine the right of track and prevent failure. But he should endeavor to get her to the terminal with as much of the train as can be handled, instead of killing her at stations as he is often forced to do in order to keep other trains moving. It would seem more practical to bring the inferior engine in with a tonnage that would insure schedule movement of train.

Engine failures—men failures—or failure to prevent failure result in delays to trains and reduction in tonnage and at times it appears that if the same effort were expended in preventing the failure as is manifested in fixing up the engine failure report after the failures have occurred, there would be quite a reduction in the number of failures and a corresponding improvement in the service.

The train dispatcher wants the power and gives the roundhouse a "jolly" over the phone—wants the engine to get the train out of the yard; will get her right back and give you all kinds of time to do the work next trip. The engine is allowed to go. A failure is the result, and the train dispatcher forgot all about the condition of that engine and his promise to get her back until he required information for the engine failure report so the failure could be charged to the mechanical department. On the other hand, had the roundhouse foreman informed the train dispatcher that he could not have the engine until she was in proper condition for service there would have been less liability of failure and a saving of overtime for engine and train crew.

The engine failure report from the train dispatcher cannot give complete information regarding the failure in all cases, for the reason that it is impossible for the train dispatcher to obtain it from the engineer. Engineers are rather cautious about sending reports of defects existing on an engine on snap judgment when there is a possibility of having to apologize for it later in the office of the Master Mechanic and usually give the train dispatcher only enough to satisfy him as to the nature of the failure, such as knocked out cylinder head, engine not steaming, etc. When the dispatcher asks why not steaming, he will often get an evasive answer or none at all, because the engineer hesitates to place himself on record until he is fully satisfied that he has located the defect. It may be possible that it is a man failure and he desires time to think it over and have the best explanation he can make up ready on arrival at terminal.

To illustrate a combination failure: An Atlantic type locomotive, handling a passenger train of less than 400 tons, broke a link hanger, drifted into the station and the train dispatcher was notified of the failure. After some delay an engine from work train service, with small wheels, was sent to relieve the passenger engine. The work train engine soon ran hot and had to give up the train, and a freight engine was provided. The delay resulted in the train being delivered to the connecting line three hours late charged with an engine failure. The defect in the hanger could not be detected by the engine inspector at the terminal. This caused the failure. When the failure occurred had the engineer blocked the links on that side at a cut-off that would have insured the proper handling of the train, he could have made the time and prevented both the man and the engine failure. He was not equal to the emergency

and lost the opportunity to prevent the failure or obtain a credit mark for himself.

There are numerous combination failures which in the end are not chargeable to the man, the operating department or the mechanical department, but are charged to the railroad company and result in increased cost and loss of revenues. While reduced expenses in shops and roundhouses are desirable, the efficiency of the service should not be overlooked in making comparisons and the reduction of a very few engine failures would often pay for the additional force necessary to maintain the equipment and allow the engine to leave the terminal with less possibility of failure. The enginemen should be educated to meet and overcome reasonable failures and bring trains to destination with as little delay as possible. There are many engineers who prevent failures and bring in trains when a defect exists, that with less skillful men would be charged as an engine failure. In one case the roundhouse foreman is the only one who will know about it, and in the other it may attract the unfavorable notice of the General Manager.

With engines in proper conditions, manned with engine crews that study their business and are interested in giving A No. 1 service and willing to exert themselves beyond the requirements set forth in the schedule of compensation to prevent failure, and a train dispatcher that will receive a suggestion from an engineer, who may briefly state a condition or a defect that may cause a failure unless suggested movements or reductions in tonnage are made and the entire transportation force working together to get traffic over the road for the company instead of for the particular department with which they are connected, the reduction in failures and improvement in the service should be apparent.

The blank breakage reports shown in the paper are very desirable and furnish correct information that is of value to the mechanical departments, as well as to the builders of locomotives.

Mr. M. K. Barnum (C., B. & Q. Ry.): It seems to me there are two objects in the reporting and discussion of engine failures, viz., information and improvement. For the purpose of information the reports are worthless, or worse than worthless; they are misleading, unless accurate and reliable. The author of the paper has covered this point quite fully and I can only add the suggestion that both the engineer and conductor should be required to sign telegraphic reports of engine failures, as in my experience that has been necessary to get a trustworthy report. Reports sent in by the conductor alone, or by the conductor reporting something that the brakeman took verbally from the engineer are very apt to cause misunderstandings at headquarters.

It is very desirable that all the railroads should agree upon one definition of an engine failure, for statements of engine failures made by different roads are not now uniform. The definition given

in the paper is probably as liberal toward the mechanical department as any in effect. Another extreme definition used by a road in the west is as follows:

"All delays of any kind whatever chargeable to engines."

That is pretty broad, to say that practically any kind of a delay that can possibly be charged to the engine is an engine failure. The road with which I am associated has adopted the following definition, which is midway between the two extremes, and we believe fair to all concerned:

"A delay of more than two minutes to a passenger train, or more than five minutes to a freight train, when caused by any defect in its engine."

A set of rules similar to those of the North Western Road given in the paper, have also been adopted, but differ from them in some particulars. Delays when once made are not cancelled by afterwards being made up. The reason for this is that we think one of the primary objects of such a report to be information, and if so the information should be given even though the delay is afterwards made up. The smaller limit of time allowed before reporting an engine failure is also thought to be in the interest of good service and makes the report more valuable.

Improvement is really the most important object of the reporting and discussion of engine failures and the authors most valuable suggestion toward that end is this:

"No engine should be permitted to start on a trip unless the roundhouse foreman is sure, to the best of his knowledge, that the engine will make the trip successfully, if it is handled properly and is not delayed unreasonably."

Where this rule is followed faithfully and it is understood by both the mechanical and the transportation departments to be absolute and final, that in no case will an engine be turned out until it is in shape to be reasonably sure of making a successful trip, the engine failures will be few compared with the road where they are turned out simply because the transportation department crowds the roundhouse foreman for power.

It is very desirable that all roads should adopt a uniform definition of an engine failure and also uniform rules for reporting them if possible, so that an intelligent comparison of performance on different roads can be made which is not now possible. Under the definition and rules adopted by the road with which I am associated, an average of less than 5,000 engine miles per failure is considered poor, from 5,000 to 10,000 engine miles fairly good and anything over 10,000 engine miles per failure is satisfactory.

I think that one of the most important suggestions in the paper is that pertaining to reports of defective machinery which are sent to the Assistant Superintendent of Motive Power and through him to the Mechanical Engineer for his files. By faithfully following

G. 808. 5m

CAUSE O

Hot B
Engine Truck Bo
Driving Box
Trailer "
Tender "
Crank Pin
Eccentric
Machine
Crank Pin
Cross Head
Cylinder Cock
" Head
" Plug
Eccentric, Broke
" Slippe
" Blade
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Frame, Broken
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Rocker Arm
" Box Bolt
Rod Bolt
" Key
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NOTE—Switch Engines

Burlington Route

Chicago, Burlington & Quincy Ry. Co.

Instructions for Reporting Engine Failures

EFFECTIVE JULY 1, 1906.

DEFINITION OF AN ENGINE FAILURE.

A delay of more than two minutes to a passenger train, or more than five minutes to a freight train, when caused by any defect in its engine.

RULES GOVERNING REPORTS:

1. **Time made up after a failure** occurs does not cancel the failure, but the amount made up should be shown on daily Engine Failure Report, Form No. 2218.
2. **Consequential delays to other trains** should be excluded from daily report Form No. 2218, as they are shown on the A. M. report.
3. **Show the same engine only once on Form 2218** for failures on the same train, but specify all causes of failures.
4. **Engineers running through** over two or more divisions with the same engine and on same train should not be charged with more than one failure on account of the same defect.
5. **Reports of engine failures** must be signed personally by both engineer and conductor.
6. **Reports should be accurate and explicit,** and indefinite expressions such as "no air," "no steam," "engine not working good," "working on engine," etc., should be avoided.

THE FOLLOWING DELAYS WILL NOT BE CONSIDERED ENGINE FAILURES:

7. **Anything occurring to an engine before** it leaves the roundhouse or after it leaves its train at the terminal.
8. **Delays to a train in a terminal** yard on account of waiting for work to be done on an engine which is ordered to take the train through its usual terminal.
9. **Delays to a train caused by its engine being taken** to handle another more important train, on account of failure of the latter's engine.
10. **Delays to switch engines.**
11. **Delays due to accidents and derailments,** of which the engine is not the primary cause.
12. **Delays due to the engine striking dirt** or other obstructions on or beside the track.
13. **Delays due to air sticking on the train,** when not caused by any defect on the engine.
14. **Delays due to taking coal or water.**
15. **Delays due to running for coal or water** on account of heavy train or long hours on the road.
16. **Delays due to injectors failing to work for lack of water** in the tank, caused by being held out on the road under above conditions. (See Rule 15.)
17. **Delays due to cleaning fires and ash-pans,** if done within a reasonable time.
18. **Delays due to an engine slipping, stalling or doubling** on account of frost, weeds, wind or heavy train, provided the engine is equipped, steaming, and working properly in other respects.
19. **Failure to haul full tonnage** on account of bad weather, wind, snow or cold.
20. **Broken draft rigging on the engine or tender** when caused by the train parting or air-brakes being otherwise improperly set in the train.
21. **Work done on an engine while waiting** for other trains to meet or pass or while the station work is being done.
22. **Engines going to the shops,** either double-heading or dead in a train, are not to be charged with failures, but if handling a train alone, they are to be treated the same as any other engine.

General Manager, Lines West of the Missouri River.

General Manager, Lines East of the Missouri River.

up such reports a very valuable record will accumulate which will enable the weak points of the various classes of locomotives to be strengthened and thereby materially decrease the engine failures.

Briefly, my suggestions for keeping down engine failures are: First, all necessary roundhouse work must be found, reported, and properly done. It is quite possible to run engines successfully for some time, although about ready for general overhauling, if the roundhouse work is watched closely and kept up in the very best manner. Next, engineers should be induced to take a lively interest and pride in avoiding failures. This is a matter of education and

Y. 9-08. 2000. Form 1744.

Chicago, Burlington & Quincy Railway Company.

MECHANICAL DEFECTS IN LOCOMOTIVES.

....Shop Date..190__

Engine No.. Class..

DEFECT—Location.

Description.

Sketch

Primary Cause

Recommendation to Prevent Recurrence

Signed ....

MASTER MECHANIC.

NOTE—This blank is to be used for reporting immediately each case of broken machinery or other mechanical failure or defect found in locomotives and should be sent to the Superintendent Motive Power, who will forward to Gen'l Supt. Motive Power, Chicago.

M 7 06-5M

Burlington Route

Form 2218.

Chicago, Burlington & Quincy Railway Company.

OFFICE SUPERINTENDENT OF TRANSPORTATION.

Statement showing ENGINE FAILURES for 24 hours ending 8 A. M. 190

DIVISION	Engine No.	Train No	TIME LOST		TIME MADE UP		CAUSE OF FAILURE
			Hrs.	Mins.	Hrs.	Mins.	

....
Superintendent of Transportation.

[illegible]

Form [illegible]

Chicago, Burlington & Quincy Railway Company.

Office General Superintendent Motive Power.

RECAPITULATION

ENGINE FAILURES—MONTH OF.................................190

DIVISION	FAILURES																Total Engine Mileage		TOTAL MILES PER FAILURE						RANK					
	Hot Bearings		Machinery		Boiler		Air Brake		Miscellaneous		Total								This Month		Same Month Last Year		Last Month		This Month		Same Month Last Year		Last Month	
											This Month		Same Mo. Last Year		Last Month															
	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.	Pass.	Frt.
Chicago																														
Aurora																														
Galesburg																														
LaCrosse																														
Beardstown																														
Burlington																														
Ottumwa																														
Creston																														
Hannibal																														
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Total Lines East																														
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Wymore																														
McCook																														
Alliance																														
Sterling																														
Sheridan																														
Total Lines West																														
Grand Total																														

3″

calls for patient and persistent work on the part of all of the mechanical department officials. And, last, but not least, co-operation between the mechanical and transportation departments will prevent a great many engine failures. It is a good thing, when possible, for the Master Mechanic and Chief Dispatcher and Superintendent to have frequent visits together; we may call them heart-to-heart talks, and in this way they will anticipate and avoid many things which otherwise would develop into engine failures.

President Bentley: I think you are entirely right, Mr. Barnum, about the uniform system of reporting failures and what constitutes one. It might be a good thing to bring up before the Master Mechanics' Association, to have a committee appointed to look into that thing. Mr. Seley, have you anything to say?

Mr. C. A. Seley: I have not very much to say, Mr. President. The matter of engine failures can better be discussed by other people present. I would say, however, that the forms showing pictures and drawings of parts will certainly facilitate getting reports from the road. We have a report on the Rock Island on which the broken parts are supposed to be sketched and sent in for our information. It is pretty hard to get these adequately filled out, and I think we are short a great deal of information by reason of not perhaps making it easier for obtaining sketches somewhat in the manner shown up in the paper.

I have with me all the forms that are in use on the Rock Island road for the various purposes in reference to recording engine failures and so on, and if any of them should be desirable for reproduction in the record, they are at your service.

President Bentley: Is there any engineer present running an engine who can tell us how he can prevent engine failures, or what we are responsible for, and how we can overcome engine failures for him? We would like to hear from him. Is Mr. Jeffries here?

Mr. B. H. Jeffries (Wabash Ry.): I have had a few engine failures like other engineers. The forms gotten up by the North Western to define engine failures are something I have never come in contact with before, and I heartily approve of them. There are one or two things I believe can be added to it, however, that might be of benefit. Mr. Dunham states that delays that should not be charged up as engine failures should include cleaning ash-pans, etc., which are all right. There is another thing that causes more engine failures, and especially at this time of the year perhaps than any other one thing, and that is "no steam." That is not always caused by poor engines. In many instances it is caused by new firemen that are being worked in at this time of the year when the railroads are hard up for men. In many instances it is caused by poor coal. One thing that I want to speak about tonight is the honey-combing of flues, caused by certain kinds of coal, that an engine in first class condition will have. There is no provision made

for that in this list prepared by Mr. Dunham, and I would like to ask whether you think that, if it is necessary to stop a train on the road in order to remove honey-comb from flues, it should be charged up as an engine failure or not. I have seen times when it took considerable labor and a great deal of time to remove it and it is very injurious to the engine to remove it. The only way to remove it in some instances is in direct violation of the rules of taking care of a boiler, that is, opening the firebox door, putting on the blower and both injectors and cooling her down. We know what that does to a boiler, but that is the only way to get honey-comb off sometimes, and then one has to knock good and hard.

It has always been a source of wonderment to me why certain delays caused by some engines are so much more important and cause so much more furore than any of the other numerous delays which we have. It is a fact that the dispatcher can make a poor guess and lay you out twenty minutes and there will not be much said about it, or a sleepy block man can stop you and there will not be much said about it, but you stop five minutes to treat a hot pin or some other cause pertaining to the engine and see whether there will be anything said about it! There is a wonderful discrepancy in time, too, that I never was able to understand. When a dispatcher lays you out and you look at your watch when you stop and you look at it when you pull out, we will say that he has delayed you ten minutes, you get hold of the situation report next morning and you will find that that time has diminished until it is only about three minutes, but if you stop somewhere on account of something wrong on the engine and only consume three minutes, when you come to look at the report it has swelled to ten minutes, and I never could understand it.

President Bentley: That must be the train dispatcher's equalizer. Mr. DeVoy is here; I would like to ask him if he has any blank reports that he keeps in his office for the purpose of finding out the weak spots on the Milwaukee engines.

Mr. J. F. DeVoy (M. E. C. M. & St. P. Ry.): I thought the Chairman would have known that my friend Jeffries started enough trouble here without asking me to give a talk on this subject, but you have started the ball, so I suppose I ought to say something. There is perhaps no paper which could have been brought up which would have caused any more discussion or could have been of any more benefit either to the engineer on one side or the dispatcher on the other side, than this paper. So far as I am particularly concerned, I do not think the train dispatcher is a very bad fellow; and I am just as sure as that I am here tonight that if you force him to swell that three minute delay or diminish the ten minute delay, if you force him to give you an itemized account of every failure and what it was, he would require so many bookkeepers that there would not be any train dispatchers left.

I believe, so far as the diagrams are concerned, that there is nothing better to determine engine failures. I do not just understand how the writer of the paper intends that we shall keep track of them. I have been looking them over now for twenty years; I look them over every morning, and I never will forget my first two years in railroading. I had a job assigned me which was to take the diagrams of couplers, and mark a little red line where the defect occurred, and I have gone down to the shop more than one cold morning and hauled those couplers over until I said more than I would like to say tonight. And I want to say right here to you that a man will talk a great deal louder than I could talk if you forced him to keep on marking engine failures anywhere outside of what is ordinarily termed a "back" shop. If, for instance, your grate rigging is giving you trouble, you will find if you use dump grates, a man will put "dump grates" down every morning as a cause of failure.

Let me tell you something laughable. I get our engine failure reports about half past eight every morning and yesterday morning there were three causes of failures; the first one was, the bell tongue fell out; the next fellow lost his air pump; the next fellow lost his water valve, and every man in the office came in to me in turn to know what the water valve was. I told them I guessed the fellow's water can leaked or the spout fell off. But, seriously now, you will find somebody outside of the dispatcher causing trouble, and the dispatcher is just as bad as you can make him; there is not anything worse. If you would get on an engine tonight (I am going to try it), and ride from here to Milwaukee, you would probably get up to the North Western and Pacific Junction and he will hold you up for four or five minutes; then get up to Rondout and he will hold you up another four or five minutes; then get to the C. & E. I. crossing and he will hold you up there and then you have got to make it up before getting to Milwaukee! You have no business to be an engineer if you cannot make it up. When you get right down to business, gentlemen, no matter whether you are a mechanical man, train dispatcher, operating official or engineer, you are not very much good in this age unless you have something up your sleeve ready for an emergency.

Now, to my mind Mr. Durham, who belongs to the mechanical engineering profession, ought to have told you that 50 per cent (I believe it is true of every road in the United States) that 50 per cent of the failures of locomotives are due to inherent or bad design in boilers; that is, the boilers have caused 50 per cent of the trouble, and I want to say to you right here that we are not paying enough attention to the design of the boiler to bring it where it should be. I do not dare talk narrow firebox, because you think I am "daffy" on the narrow firebox; I do not dare to go to the wide ones, because I know they are wrong; but I do believe this, that it

is entirely possible for the mechanical engineering department of any road to overcome 25 per cent of the failures of locomotives themselves, without the aid of any train dispatcher or anybody else. You have to build a boiler today that will not fail and you can get pretty near to it. I did not get the paper until this morning and there is another case where neither the engineering department nor the train dispatcher was at fault. I would have had a little bit more to say if the Secretary had gotten the report to me sooner, but it only came to me this morning and he has to get his tonight with the rest. But in looking through the reports this morning, I took particularly the boiler failures, and I found that a certain type of boiler for the past thirty days had given 55 per cent more failures than any other type. You will have to guess about those types, because I have talked about them, both the narrow ones and the wide ones, and I believe that if we could get together on that part—the engineering department I am talking about now—that we could eliminate to a certain extent a great many of those failures.

I think the paper is a good one; it is one that ought to have been brought up; it is one that engineers and train dispatchers ought to prepare themselves upon, but I do not know how we are going to follow up all the rules. If I do I will have to go home and ask for an increased clerical force to the amount of about a dozen clerks to keep my business up.

President Bentley: Gentlemen, this subject is a very important one. Mr. Peck, can we hear from you?

Mr. P. H. Peck (M. M., C. & W. I. R.R.): You ought to treat engine failures as I do. I treat them just as Chicago treats the Drainage Canal; it is a good thing to throw anything into that you want to get rid of. It does not make any difference, you know. The train department, Train Master, General Yard Master and everyone can throw everything on the engine they want to. I was rather surprised that Mr. DeVoy says it will take dozens of clerks to follow these rules; he must have a terrible lot of failures. The Milwaukee road has such fine engines, I do not see why it should take so many clerks to do that work. For a man who has the usual number of failures and on as good a road as the Milwaukee, one clerk suffices.

One thing that causes a great many failures, is shortage of power. They talk about the roundhouse foreman not letting an engine go out unless he is sure that it will make a trip successfully. We would all like to do that, but when trains come in late and the engine is cut off at the lower end of the yard and has to go back again in a few minutes, it is impossible to do good work. We are all crowded for power; we do not have much trouble with engine failures due to boilers; our boilers must be of a better design than Mr. DeVoy's. Our boilers pan out all right, but the other parts wear and tear, and I say that one reason why we cannot take proper care of them is be-

cause we are crowded for power in cold weather, and then is when most engine failures occur.

MR. DEVOY: I want to inform Mr. Peck that the day before yesterday morning—and I believe Mr. Barnum will bear me out in this—I saw a statement compiled by the Santa Fe, in which the engines on the St. Paul road had made more miles than any road in the United States—no, pardon me, had made more engine miles per engine failure than any road in the United States except one Southern road, and that the cost per engine mile for repairs was second on the list of about fifty, so I think he will not say that we are quite as bad as some of the rest; the boilers have not been as bad as they might be. I think if a man will take the time to enquire, he will say, "Well, the Milwaukee is not quite behind the drum major, but it is along in where the clarionets come in the band; it is not way back in the procession."

PRESIDENT BENTLEY: We have heard from the train dispatcher and of the train dispatcher; we have heard of the locomotive engineer and mechanical engineer; I would like to hear from the roundhouse foreman, or somebody who has come in close contact with the train dispatcher when he is short of power. Mr. Barnhart, can you tell us how you handle the matter?

MR. A. H. BARNHART (Foreman C. & N. W. Ry.): I get an order about every day for one or two more engines than I have. At the point where I am located all the engines are assigned to regular runs and we have very little extra work except on Sundays. When an engine plays out we are compelled to double one of the others. This gives us sometimes two hours, sometimes one hour and sometimes no time at all in which to get the engine ready for the run. I have always made it a practice, that no matter how urgent the call for the engine was, to hold the engine for necessary repairs, the repairs that in my judgment were necessary to enable it to do the required work before coming back to the house. As a result of this we have had few engine failures in this district.

I believe the greatest cause for engine failures is the lack of proper inspection and the failure to make proper repairs. I believe that three-fourths of the engine failures could be prevented by proper inspection and proper repairs being made. My experience has been that to have proper repairs made it is necessary for the roundhouse foreman to be constantly on the ground and see for himself that the work reported by the engineers and inspectors is done and done in a proper manner.

MR. PECK: That is the great trouble; they have not the time to work on engines because very few engines have assigned runs. With our engines the rule in the summer time is, "First in, first out." In the winter time it is, "First in, right out;" then we have trouble.

PRESIDENT BENTLEY: There is no doubt but that the enormous

business the railroads of this country have been called upon to handle in the last year or two has made it very hard for not only the mechanical, but also for the operating departments, to keep things going, and the pooling of engines, of course, has had its share in bringing about the condition that favors engine failures. I do not suppose that within the next twelve months to come, from the business outlook, we will be able to give regular engines to regular men. I wish we could, because I think it would obviate a good many of our troubles. Now, gentlemen, do not wait to be called upon. The hour is not yet late and we would like to hear from everybody.

MR. A. J. COTA (C. B. & Q.): Mr. President, I believe a great many engine failures could be avoided by a closer roundhouse inspection. I believe it is a good plan to have engines thoroughly inspected in the roundhouse. We are all after engineers to make a work report showing all defects that they find on engines on their arrival. In addition to this each roundhouse should be provided with sufficient engine inspectors to make a thorough inspection of the engines. All work reported by the engineer and all work reported by the inspector should be attended to before the engine is allowed to go. On the road that I am connected with there is an order that all engines must be put in first class condition as far as the roundhouse foreman can judge before they are allowed to leave, and I think that points of that kind do more to reduce engine failures than any other.

T. S. REILLY (Railway & Engineering Review): A point has been brought up bearing on the relation of long hours on the road to engine failures. This reminds me that sometime ago I took the trouble to collect some data to ascertain the percentage of time locomotives are actually required by the mechanical department for maintenance purposes. Figures were obtained from a busy division on each of three of the largest single-track systems running out of Chicago. Considering the total number of locomotives, multiplied by 24 hours, multiplied by 30 days—as representing the number of engine hours the locomotive investment represents, the averages exhibited the locomotives required by the mechanical department for roundhouse purposes, as follows:

Passenger, 21.2 per cent of their life; freight, 33.9 per cent; switch and work, 50.6 per cent, so that the average showed the mechanical department required the locomotives 28.5 per cent of the time. A striking feature, however, was that of this 71.5 per cent of the time the locomotives were available by the transportation department, but 43.3 per cent (of this 71.5 per cent) was utilized in the actual movement of trains. So that, of the investment represented by a locomotive, 28.5 per cent is used up by the mechanical department for maintenance and supply purposes, 11 per cent in lying idle in the hands of the transportation department, and 60.5

per cent in actually hauling trains. In other words, 39.5 per cent of the investment in locomotives is not utilized for the purpose for which the investment is made.

The roundhouse foreman has been held up here as responsible for a large portion of engine failures. I consider the position of roundhouse foremen one of the most difficult on a railroad, if not the most difficult. He has no prestige, his pay is a matter of ridicule; it is generally his first experience in an executive capacity; he is the storm center of locomotive operation and maintenance. Seldom is either his force or facilities equal to his needs, and he must constantly exercise the highest judgment and diplomacy to successfully equalize mechanical with operative needs. Yet we are observing a present disposition to give "shops system" cranks full swing, with ideas which seek to specify the repairs which locomotives shall receive, before they reach the back shop. In order to let these faddists exhibit paper records, it is becoming the order of the day to say in advance that a locomotive coming into the back shop shall receive repairs to the amount of $800 or $1,200 or $2,000, and no more.

In the light of considerable practical experience I, for one, consider such propositions not only absurd, but that such "paint overhaulings" are the principal cause of the abnormally large percentage of engine failures in evidence during recent years. The only way to overhaul a locomotive is to strip it and thoroughly overhaul it—in the full sense of the word. It is impossible to properly inspect and state in advance the amount and cost of repairs such complete stripping will reveal. And the subterfuges resorted to in this regard by shop system idealists to escape this fact—results in the furnishing of roundhouses with power which is supposed to be, but is not at all in the condition locomotives should be on emerging from the back shop—as is well exhibited in the daily engine failure report, despite the superhuman efforts of the earnest roundhouse foreman.

Mention of the dispatchers in relation to engine failures reminds me of an official not yet brought into the argument tonight, yet whose duties are, or should be, chiefly concerned with the subject, viz.: the traveling engineer. The point I want to make in this connection, is that if the dispatchers and the traveling engineer keep in touch when he is on the road, many engine failures may be obviated by the dispatcher dropping him a wire about a man who may be in trouble in his vicinity and, moreover, the traveling engineer will know who is, or is likely to be, in trouble and where to find him, thus enabling the best disposition of his efforts.

In regard to the paper itself, it strikes me that the essential point is that the Chicago & Northwestern Railway has established a good precedent in defining engine failures as in this list. There are very few lines which have established the definitions of an engine failure

and in the absence of such clear definitions, there is a great deal of lack of harmony between the mechanical and operating departments. For instance, I notice in Rule 13 it says, "Do not report delays when an engine gets out of coal and water, caused by being held between coal and water stations an unreasonable length of time." One of the worst controversies I ever had with the operating department was over that very thing. I charged such engine failures to poor dispatching; they claimed that there could not be an engine failure on account of poor dispatching. It was mentioned here, by one of the correspondents, I believe, as being of very great benefit if railroads could make and establish a uniform list of definitions of engine failures. I believe there should be put in practice on all roads a standard ruling something along this line already established by the C. & N. W. Ry. I understand the present example has been in effect several years and it is therefore well proved as having been well worked out in actual service.

Mr. M. H. Haig (Railway Master Mechanic): In discussing this very important subject of engine failures, I have heard several sides of the question brought out; for instance, the engineer, the train dispatcher and various others. I would like to hear someone discuss the question of the effect of long divisions with regard to engine failures, especially in handling very heavy trains. I have heard it said that 50 per cent of engine failures occur during the last few miles over divisions of unusual length, where handling heavy tonnage. This is on account of the fire becoming dirty, especially with green fireman. Such conditions aggravate the tendency for flues to leak, etc. I would like to hear someone who has had experience on long divisions.

President Bentley: Is there any gentleman here that has a division of 250 to 300 miles that can make any suggestions on that question?

Mr. R. E. State (R. H. F., C. R. I. & P. Ry.): Our division on the Rock Island is, I believe, 159 miles for freight engines and the way we get after the engine failures is with the best boiler makers we can get. Good boiler work is very necessary. Next, the best inspection that can be given; then follow up the machinists that they do the work that is given to them. The Illinois Division for December showed one engine failure in freight service to 42,000 miles.

President Bentley: That is a very good record. I do not believe there is anybody in the room who can duplicate that report.

Mr. State: In September it was 44,000 miles in freight service and in passenger service it was 24,000 miles.

Mr. Barnum: I would like to ask the definition of an engine failure prevailing on the road of the gentleman that just spoke.

Mr. State: The dispatcher turns in an engine failure, and he

generally puts in all there is to it. It is investigated most thoroughly, and, if just, it stands. If not, it is cancelled.

PRESIDENT BENTLEY: How bad can you stand? (Laughter.) I would like to have some information given in line with Mr. Haig's request about long divisions. There is not a doubt about it, if you have a 200-mile division, that at the tail end of the division, especially if it is uphill, the engineer and fireman get tired, the firebox gets into bad shape, the flues begin to honeycomb, and a long division is responsible for many engine failures. If there is any gentleman here who can give us any information in line with that suggestion, we will be glad to hear from him.

MR. GEO. L. BOURNE: I used to have the somewhat doubtful pleasure of running an engine on a long division, the division being a 175-mile freight division and Chicago the eastern terminal. We had joint track at each end of the division, which, of course, made it hard to get to terminals, and usually consumed from ten to twenty hours getting over the division. It was a frequent occurrence to have to clean a fire within ten or fifteen miles of either terminal, and this, of course, constituted an engine failure. With a dirty fire and the firebox almost full of clinker and shale, as long as a man can keep the engine moving and keep the clinker warm, it is possible to get to the end of the division; but when, after worrying along with a dirty fire and consequently a poor-steaming engine, after reaching the terminal we had to go to the stock yards with our train of stock and consume anywhere from two to six hours between Western Avenue and the chutes, and getting back to Western Avenue, I do not think there was any excuse necessary for an engineer to give as to why he had had an engine failure. Often times it was necessary for the men on this division to clean fire when on stock yard terminal tracks in order to get their train of empty cars back to their own terminal yard.

On the other end of the division there were about twelves miles of very heavy grade, and a vivid recollection of the necessity of having a clean fire in order to make the last forty miles of this division and haul the tonnage leads me to believe that this division was just sufficiently too long to make engine failures.

It gives me a great deal of satisfaction in listening to the discussion here tonight to know that there are others responsible for engine failures besides engineers. I do not think I was any more conscientious than the average engineer, yet to me there was always a nightmare about an engine failure; I knew there was always an explanation necessary and I always thought I got the worst of it. Is it not a fact that the engineer has always been blamed more or less for engine failures, and is it not due to the fact that the transportation department has been successful, in a great many cases, in having a delay charged as an engine failure whether it was so or not? I have often times had an opportunity to prevent an engine failure

by a little attention given to the crosshead, rods, or wedges, as the case may be, when taking water, but if I did not happen to be through by the time the fireman had finished taking water the mechanical department was charged with an engine failure; but if a train crew starts to pack a hot box, or put in a new brass when an engine crew is taking water and are not ready to go for ten or fifteen minutes after the engineer has gotten his clearance and is ready to leave, it is very doubtful if a train failure or delay report will show up on the dispatcher's sheet. It may not be that it is always deliberately covered up; for instance, it is an easy matter for the conductor to take five or six minutes to walk back to the caboose before he is ready to go.

I think that if the mechanical department, and the engineers in particular, were to get a little more credit for endeavoring to avoid engine failures, this source of worry to the operating and mechanical departments could be eliminated to a very great extent. By that, I mean if the mechanical department, or its representative, the engineer, can by five or ten minutes' attention to the engine between terminals prevent an engine failure and make up the time lost before reaching terminal, should not the mechanical department really be given credit for preventing an engine failure instead of being charged with one?

Mr. W. E. Symons: It is pretty generally conceded that we are all, more or less, the product of our environment. It is also equally true that many of us have a great deal to do with shaping our environment.

It is also pretty generally known that "engine failures" is a rather ambiguous, or flexible term in its application, and meaning, so much so, that when in the hands of certain railway officials it can be and is sometimes used in a manner to cover a multitude of sins, the sum total of which might, in justice to all departments and branches thereof be sub-divided, making quite a conspicuous change in the ledger account.

I am fully in accord with my friend, DeVoy, who, I believe, has left the room. I do not like to quote a speaker after he has retired, as he might want to answer, if criticized. However, I do not challenge anything he has said in reference to the train dispatcher, but quite agree with him on this particular point.

It has been the speaker's lot to mingle and work with all classes of officers, and employees of railways, also steam-ships, industrial concerns and commercial men; I have associated with train dispatchers, both in a social and business way, worked with them, shared their troubles and joys, ate with them, slept with them, solved difficult problems with them, and always, with equally as satisfactory results, as when dealing with any one else. Generally speaking, my observation of railway men is that they are all molded out of about the same kind of clay, it being rather a question of our own

environment as to what particular value or importance we attach either to ourselves or the other fellow.

The train dispatcher, however, is quite an important factor in the matter of engine failures on most railways, and on roads where the train dispatchers and enginemen, or, I might say, the transportation and mechanical branches of the operating department are not friendly and working in harmony, as they should be, engine failures are, as a rule, rather excessive according to the records, and in the investigations as to the cause, and the explanation offered, there are many criminations and re-criminations. It, therefore, follows, that an investigation of a report showing on its face an engine failure for every one, or two-thousand miles on a certain railway is not conclusive evidence in all cases, that the motive power is in bad condition; also a report from another road, showing twenty-four to forty-thousand miles per engine failure may not be proof, or evidence of the machinery being in good condition. Either, or both reports may reflect a condition, which does not apply to the locomotives at all, but rather to the efficiency of the men, character of organization, discipline, etc., and either the harmonious relations or opposite conditions that may exist between employees, and officers, all of which it will be found, when properly analyzed, can yield only to a thorough systematic re-organization.

All of the remedies offered here this evening, together with others, that any practical, sensible man would offer for the solution, or prevention of engine failures are predicated upon the assumption, that the officer in charge of that particular branch of the service is supplied with the means, and clothed with the authority essential, either to prevention, or remedy; therefore, a roundhouse foreman, division master mechanic, or even superintendent of machinery, who may have evolved in his mind and reduced to a definite conclusion, a system, or method whereby engine failures would be as completely eliminated, as is practical in the operation of a railway, might at the same time find himself restricted financially, or confronted by a feature of the organization adverse to his department which would preclude the possibility of his system, or method being applied, to the end, that desirable results be obtained. Therefore, if my reasoning is sound, I would suggest, that following in the line of the remarks of our President, it would be an excellent thing to formulate some method by which the question of engine failures could not only be uniformly, and intelligently compiled for comparison, but that the subject be taken up with the Master Mechanic Association. Its presentation, however, should be on the ground, that all items entering into, or having any bearing on a engine failure, should be included in the report, with full explanation in detail from each road. The statement should show, among other things, the kind of engine, their dimensions, age, heating surface, grate surface, tractive power, profile of line over

which they operated, speed maintained, amount of money expended on each engine each year, kind of water used, details of fire box and fuel renewals, company's facilities for repairing engines in the way of shops, roundhouses, etc., this for the reason, that on some roads, a cost of 8 or 8-½c per mile looks very economical, while on another road, a cost of 12 or 15c looks high, when in reality sometimes the road showing the lower cost is not as economically handled as the one showing the higher; this is sometimes a matter of book-keeping. The matter of facilities exert quite an influence not only on cost items, but on the number of engine failures.

Engines in first-class condition sometimes on their arrival at a terminal point when stood out-doors in zero weather get to leaking about the time they are needed by the transportation department, and an engine failure is reported, when as a matter of justice, the General Passenger Agent, Auditor, or Treasurer of the road is just as much to blame for the engine failing as is the superintendent of machinery; therefore, any general report of the different roads compiled for comparison must be made on the same basis containing the same items of expense and other conditions, so that, it will be susceptible to the same method of analysis, thereby, giving results, that are reliable, and can be quoted, even if the engines are maintained under different conditions.

The comparative statements showing the cost of maintaining locomotives on a number of prominent railways, that were published for a number of years in Mr. M. N. Forney's very valuable paper were finally discontinued, for the reason, that the comparisons reflected adveresely on some of the best managed roads, and, on account of the different systems used, of arriving at the expense charged to repairs on different roads, together with the other local conditions pertaining to the operation of locomotives it was decided that these comparative figures were valueless.

The ambiguity, or flexibility of the term "engine failure" is made very clear and apparent by the perusal of Mr. Dunham's paper, and any one not familiar with the Northwestern Railroad, with the high character and ability of its officers and the discipline maintained could see very clearly by reading this paper, that the management was very liberal, broad-gauged, progressive and disposed to co-operate with, and throw every precaution around the mechanical department, that would assist them in furnishing power to move their trains with the least possible delay: All men are not as pleasantly situated; The Club is to be congratulated on Mr. Dunhams paper, and he is to be congratulated on being associated with a railroad where the management will authorize them to put into force and effect as liberal an interpretation of Engine Failures, as is shown in this very valuable paper.

Mr. A. L. Beardsley (A. T. & S. F. Ry.): In my limited ex-

perience in railroading I have not had a great deal of trouble with engine failures; in fact, we have very few of them.

Mr. G. W. Farmer (A. T. & S. F. Ry.): I simply wish to bring out one point in connection with engines which have passed from the round house to the back shop for light repairs and that is, that the roundhouse foreman should always get a report from the engineer of the most necessary work to be done on the locomotive while it is in the back shop. I speak about that from the roundhouse foreman's side and I also speak from the back shop foreman's side. I have always made it a point in cases like that if such report was not promptly forthcoming to go after it.

President Bentley: For your information I will say that we have a printed report which passes through the hands of the roundhouse foreman who has been in touch with the engine, and through him to the Master Mechanic, showing the various parts of the engine requiring repairs, so that the work can be done without tearing everything apart.

Mr. J. A. Carney (S. S., C. B. & Q Ry.): Reports of delays whether from the dispatcher or from the engineer, should be made with the intention of being absolutely correct so that any investigation which may follow from such reports will be made with the idea of finding out what is wrong and what can be remedied, rather than implying a censure on any particular person. I have known of cases where engineers would not report work on their engines, and would not report engine failures with absolute correctness, for the simple reason that they thought by shading the truth they could escape censure. All of the reports that a railroad company asks for are for improvement of the service and if these reports are made intelligently and honestly the conclusions may be drawn accordingly and the necessary corrections made without necessarily making a personal censure. I think that Mr. Dunham's paper is leading up to that line of argument and if we want to know the exact truth, we must start with the truth.

Mr. E. R. Webb (M. M., Mich. Central R. R.): Mr. President, unlike our friend Beardsley, we have engine failures. We have them in all their phases and any time an engine stops for any reason that can be attributed to the engine, it is accounted an engine failure, and the matter is watched very closely by myself on the division where I am.

In answering Mr. Jeffries why the engine failure was specialized while the engine dispatcher failure was allowed to pass by, it is simply a case, well, of facility. It is easier to attach the blame for the engine failure, and there are reasons for that too. The locomotive is the important part of the railway system; when it stops it all stops and the consequence is that it is the part that is looked to the most.

In regard to the engine dispatcher, I have been fortunate in work-

ing among men who do business on the square. I ran an engine a great many years and have yet to find any time when I thought I got the worst of it from the train dispatcher. Mr. Symons expressed it just right; we are all built of much the same kind of clay and the train dispatcher, I have found, uniformly, to be a very good sort of a fellow, and if given a fair show he will be fair with the other man too. The train dispatcher's office is very close to mine and one of my first visits on my morning rounds is to inquire of the train dispatcher how things went during the night, and I head off numerous failures and get in touch with failures just through that office, not by being a good fellow with the train dispatcher, but because he is able to give me information that is valuable to the locomotive department.

Engine failures, speaking broadly, are simply the result of a condition imposed upon machinery that it is not capable of standing up under. The roundhouse foreman is, I believe, the keynote to the situation. With a first class man as a roundhouse foreman, with facilities, with adequate help, the engine failures may be reduced as well as could be expected. The tacking on of the engine failure to the locomotive engineer certainly should be a thing of the past. With us practically all the locomotive engineer has to do is to run the engine; roundhouse men clean the headlights, fill the grease cups and set up wedges; we do expect that a resonable inspection shall be given by the engineer on arrival at the terminal and also on taking the engine out. However, I have found that by inspecting the engine carefully, insisting that the work be done and by keeping in close touch or keeping the department in close touch with the division superintendent, we are able to send the engines out in a condition that will insure a safe journey over the road. The division superintendent does not want the engines sent out unless they are washed and cared for and unless we can reasonably guarantee to him that the engine will make a round trip. The result is that the engines are kept washed and the washing of our boilers is a great factor in eliminating flue failures. The roundhouse foreman must be such a man as will adopt what the engineers have been allowed to cast off. We do not hold them responsible for many things. A failure that looks like a man failure is certainly followed up, but it is not followed up with maliciousness nor vindictiveness, it is followed up for the purpose of educating the man, and we find it very successful.

Speaking of engine failures, we have about 200 miles on this division that I am responsible for, and we run anywhere from 20,000 to 40,000 miles per month per failure, but the roundhouse work must be attended to. Referring to what Mr. DeVoy said about losing an air pump, one of our young men nearly lost an air pump, but not quite. Over in the Stock Yards district an air pump broke away from its fastenings, but he got a chain and chained it. The

engine was of the extended wagontop type and the air pump was right beside the dome and the engine came in with a train of stock, (there was no delay to the train,) with the air pump chained to the boiler. I was so struck with the practical idea that I brought some of the old heads around to see what one of the young heads had done.

There is no use in attempting to fasten an engine failure on an engineer when the condition of the engine is such that it can be plainly seen by a practical man that it belongs to the engine. The pooling of engines is practiced by many railroads and it is in full force with us this winter. There are a few of the passenger trains that have regularly assigned engines, but the freight business between Chicago and Buffalo and the Straits of Mackinaw is handled entirely by engines and engineers and firemen in a pool service, which is quicker and the only way to handle freight to-day and handle it successfully with a limited number of engines and a maximum volume of business. As I have previously mentioned, the roundhouse foreman should feel an interest in the engines similar, as much as can be, to the interest which we formerly had as engineers in our individual engines. Of course he has a great many children to look after, but he must be just such a man and he must be given good facilities and in the end it is not so expensive after all and while perhaps it does look as though the expense could be less or that a burden is put upon the roundhouse force that the engineers and firemen in part should take, yet it is one of the things that has come with the times, one of those conditions, while it does cost money, is simply the price one has to pay for the things one has to have.

In regard to men being long hours on duty, I would say that our management does not permit a crew to go out that has not had a sufficient amount of rest, and we keep men enough so that we are able to do that. A crew that has been on duty seventeen consecutive hours is not even permitted to go out, and we have a space on the register book where the crews ask for the amount of rest they require, and it is given to them regardless of how long the train may lie in the yard. Our friend, Mr. Peck, spoke of engines being run "First in and first out" in the summer and "First in and right out" in the winter. We are all up to that condition and situation; we cannot help it. Ordinarly our engines run through from Jackson to Chicago on the passenger run. This afternoon our second No. 17's engine was cut off and the engine from train No. 10 put on the run at Michigan City in order to get an engine for the horse train tonight, and yet, with those conditions, if we follow the thing up closely, watch the engines, back up the roundhouse foreman, give him the things to do with and when he says, "I cannot give you the engine until such a time," be satisfied with that, and with a superintendent who will be satisfied that the mechanical department is doing all

that man can do, the freight and passenger trains can be moved successfully.

MR. BOURNE: I would like to call attention to the fact that twelve years ago two minutes to a passenger train and five minutes to a freight train was an engine failure and the same condition remains to-day. In those days engineers had small engines and small trains; to-day his engine is twice and three times the size of engines used in those days. Is it not a pretty scant chance for a man to get out of engine failures with the same five minutes to-day that he had twelve years ago under different conditions?

MR. BEARDSLEY: I would like to ask Mr. Webb if he charged the engineer who came in with the air pump chained to the boiler, with an engine failure?

MR. WEBB: The man was not charged with a failure, because while we were loading the stock he chained the pump.

PRESIDENT BENTLEY: I want to endorse every word you said on the subject of boiler washing. We know from experience that as we neglect our boiler washing, we increase our boiler force.

MR. E. H. DEGROOT, JR. (Supt. C. & E. I. R. R.): Mr. Webb has well said that when the locomotive stops, everything stops. That answers the question as to why these engine failures have been followed up with such vigor. They must be. Even the revenue stops when the engine stops. Mr. Peck suggested that everything nowadays is made to pound and evidently that includes the dispatcher, who is not present to speak for himself. I believe, however, that these men intend to be fair; I should regret to think that they did not. Mention was made of the desirability of having every train dispatcher qualified as an engine man. We cannot get train dispatchers at a salary of from $125 to $145 per month whose training will enable them to earn anywhere from $175 to $200 per month on a locomotive.

It seems to me that we should approach this subject from the judicial rather than from the departmental standpoint. These departments ought to get together. A railroad company pays for all the friction there is, whether it is mechanical or departmental. The departments should get together and avoid friction.

Now, just a word with reference to the education of the engine man in order that he may make the intelligent report that is demanded. There is a great deal for the traveling engineer to do in this respect. The dispatcher gets a message that reads like this: "Engine leaking, please advise." No further particulars. I believe comment is unnecessary. These men must be educated, these engine failures must be followd up, and the traveling engineer has both clearly within his province. He is not earning us any money in his office; he is not earning us any money with a stenographer or with a typewriter. We have been too

liberal with typewriters on railroads. If we could cut most of the typewriters out and do away with one half the correspondence with which we are called upon to contend, we would make money for the company.

I like this paper of Mr. Denham's because, in a clear manner, he provides a way for following engine failures up with one thing in view, overcoming engine failures. His plan is reasonable and progressive. By successive steps the investigation is passed along from the engine man to the roundhouse foreman and then to the Master Mechanic; from the Master Mechanic to the Assistant Superintendent of Motive Power, and from that official to the Mechanical Engineer, all with a view of preventing the next engine failure. Followed up, this will surely produce results.

Mr. J. H. Tinker (M. M. Chgo. & Eastern Illinois R. R.): I wish to say a few words in favor of the dispatcher. Although I want to speak from the motive power side, the road with which I am connected has had a great many engine failures these past few months. Talking the matter over with the road foreman of engines, we did not think we were getting a square deal from the transportation department, so we took the subject up with the superintendent; he assured us he would do everything in his power to help us, and he suggested that we meet him again a week later. A week elapsed and we were all very busy and postponed it until the next day. I went down to talk to him the next day but the road foreman of engines could not go with me. The first meeting we had the train dispatchers were not there, but the second time they were present and the next day we had a blank sheet; no failures at all. I have not had an opportunity to see the next sheet, but I think it was blank too, and I merely wish to show that the dispatcher sometimes is a pretty good fellow after all if you take him in the right way.

Mr. B. F. Sipp: The dispatcher seems to be a pretty big man here tonight. As I said at the last meeting he has a great many troubles. He endeavors to keep his trains on schedule time, he must attend to all wrecks, he must see that the trains handle their maximum tonnage over the road and he must explain to the superintendent next day why they did not handle the maximum tonnage. The dispatcher has a great many things to contend with, because he handles the details of the transportation department both day and night. He does not want to find fault, his object is to get the traffic over the road promptly, because behind him the traffic department is pushing him and the contracting man back of them is after the transportation department to get the freight over the road. I feel that the dispatcher wants to co-operate not only with the mechanical department, but also wih the traffic department. It has been brought out here tonight that eternal vigilance and co-operation on the part of the trans-

portation department and the motive power department is very desirable to reduce engine failures.

President Bentley: There is no doubt about it, Mr. Sipp; the train dispatcher has a hard game to play. We recognize that, and the only way to do is to help him as much as possible. I have known a great number of train dispatchers, and I have the first trouble to have with any of them. It all depends on how you handle them. I think a train dispatcher is human like the rest of us, and if you handle him in the proper manner he will be square with you if you will be square with him.

Mr. Wallace: A speaker mentioned the fact that the engineer had the engine failure put onto him. I hardly think that applies to the majority of cases and I think that the assistance that you get from your engine men will assist in eliminating failures in proportion to the ability of the men who are on the locomotive, just as much as an efficient roundhouse force will eliminate failures of engines, and I think that possibly Mr. Webb complimented that engineer in preventing a failure; if he did not I am a little bit disappointed. The engine failure that was mentioned where an engineer would be delayed two minutes after taking water could be avoided by the engineer; all he had to do was just to drill that fireman to leave the spout in the tank until he got through with his work. The engineer would have prevented that engine failure and that is just one example of many cases that an engineer could prevent engine failure.

Mr. Webb: I would like to say in reply to Mr. Wallace that I did compliment that engineer and I brought all the engineers around the engine that morning to show what the young man had done.

In regard to the co-operation of the enginemen, we have the enginemen and we have their co-operation, and just as an illustration of that, I knew that one of our engines on a passenger train had had a disabled driver brake; the train was not very far out of Chicago when the brake crank broke right off. I did not find any report or statement from the engineer and the next day I met him and asked him where his statement was in regard to the engine failure. He said, "I did not have any engine failure. They did not know a thing about it. The traveling engineer was running the engine and I took it off and before we started I had the broken part on the back of the tank and the result was no delay." The Transportation Department did not know anything about it and would not have cared if they had, because it did not delay the traffic.

President Bentley: This is one of the most interesting meetings we have had for a long time and I hope we will continue to have meetings of this character. I note with a great deal of pleas-

ure the improved attendance at the meetings and I feel sure that the interesting subjects we have had have been responsible to a great extent for the improvement in attendance. Mr. Dunham unfortunately is not here, but we will give him the privilege, of course, of replying to any remarks that have been made, as I think it is only fair, and his answers will be printed in the proceedings. The hour is getting a little late, and if there is not any further discussion, I will be glad to have the motion to adjourn.

Mr. W. E. Dunham (M. M. C. & N. W. Ry.): The true function of any system of failure reports is to give absolute facts upon which can be based the actions taken to avoid a repetition of the same or similar failures. If every one concerned in the matter of train service would keep this forcibly in mind there would be no friction between the departments nor would the engineman think that he was having it "put onto him." As regards charging an engineman with a failure, personally I do not look first of all to see if I can find fault with him. First, I want to know if the engine was in proper condition for service. If the round house is not at fault I then want to know if the engine was treated right. If the engine man or the train dispatcher is at fault I want to know that. And finally, if the engine was all right and it was treated all right I want to know if the design or the arrangement of the detail was correct for the service that it has to perform. Now the only way to get such information is to have each report honest and without any equivocation. A train dispatcher, an engineman, a round house foreman, a master mechanic, a mechanical engineer or a superintendent should stand for just what censure is due him for each and every failure that occurs, if censure is necessary, but each of them can also learn something from each failure which will be of use in their daily work and thus be of value to the company employing them.

I have had enginemen, when called up for the purpose of giving information, begin to tell how very much abused they had been and how badly they had been treated by the train dispatcher, etc. Usually the facts were that the only fellow abused was the inanimate engine and the engineman needed all that was coming to him. When a fellow begins to complain or whine I usually look out for him, no matter what position he may hold.

Some of the speakers seemed to think that I had it in for the train dispatcher. Far from it. My only endeavor was to show up some of the practices that have come under my observation that have given reports not fair to the train or the motive power department. The round house foreman, the engineman and the master mechanic are all human and they all have the human instinct to try and put it on to the other fellow. On that account I thoroughly believe in a set of rules governing the reporting of

engine failures. If the actual facts of the case are given every time there can be no chance for any argument or wrangling between the departments. If we all had the Drainage Canal as handy as Mr. Peck has to dispose of our engine failure reports we would be relieved of a great deal of worry. But if the study and time that is put on a square report of failures results in showing up needed improvements in shop and round house practices and facilities I believe that each railway master mechanic should welcome all the failures that can be charged. The motive power department is created solely to keep engines going over the road and in condition to pull tonnage. If they cannot do that we ought to want to know why. The knowledge that I get from these reports, if a standard set of rules could be adopted, would be of great value if I should be furnished with the same class of power that I have been accustomed to handle and vice versa.

The rules presented in the paper are not infallible but they have shown themselves to be very practical. Mr. Wilson, however, presents two rules especially that are good. I refer to his No. 5 and No. 11 covering delays to switching power and work done by enginemen while he is waiting for train crews or orders.

Mr. Buchanan writes that they do not accept failures where "fuel only is responsible." We do and I think we should. For Mr. McIntosh's information would say that it comes in as a cause for not steaming. It is not itemized in the list but it is clearly a cause for trouble and it is so considered. Poor fuel will cause more boiler trouble than a large force of men can repair and I believe that the fuel agent should know the results of his purchase of inferior fuel. Mr. Buchanen covers the field where he says that "there are few failures . . . which cannot be avoided if proper inspection is given the manufacture, application and maintenance of material." And I believe there is no better way to know if the proper inspection is being made than to have the other fellow tell you where you are not producing results.

Mr. Tonge refers to having dispatchers familiar with the working of an engine. It seems to me that Mr. Webb has that subject well in hand when he says that he calls on the train dispatcher and helps him line up things the first thing in the morning, thereby heading off many probable failures and in return receiving valuable information for his department. The closer the master mechanic and the operating officers can get together the better will be the results. If I was superintendent and my dispatcher knew all about the working of an engine I would dispense with the services of the master mechanic and also look for another job myself. I cannot say that I believe in these "know it all" fellows, I prefer a "community of interests."

Mr. Wallace mentions the matter of education of enginemen,

This is of the utmost importance as it is upon them that we depend to get all there is to be obtained from cur engines on the road. A man interested in his work and also a student of it will get results with an engine having a slight defect that a simple "throttle opener" can not. And a man is not in the latter class always of his own choice. We have usually made him and we have no one to blame but ourselves. I find that a failure report shows up just where we need to strengthen this man and that man and in the end make good enginemen out of them. And right here let me say to the engineman, don't be afraid to tell the dispatcher what you think should be done or ask him to help you out when in trouble. He will look to you some day and will want your advice. On the other hand if you insist on going it alone and independently he will surely let you.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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Club meets third Tuesday in each month, except June, July and August

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Vol. 19—No. 6 Chicago, February 19, 1907 **$2.00 Per Year 25c a Copy**

The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday evening, February 19, 1907, Vice-President C. A. Seley in the chair.

The meeting was called to order by the Chairman at 8 P. M.

Among those present the following registered:

Adams, C. E.
Allison, W. E.
Ayers, A. R.
Baker, F. L.
Barnes, C. A.
Barnum, M. K.
Beattys, W. H. Jr.
Benedict, B. W.
Bott, A. G.
Bradshaw, J. H.
Brown, C. L.
Beardt, C. A.
Callahan, J. P.
Cardwell, J. R.
Carlton, L. M.
Carr, E. A.
Christenson, A.
Cooley, A.
Condron, T. L.
Conger, C. B.
Curtis, J. J.
DeGroot, E. H. Jr.
DeVoy, J. F.
Dodd, T. L.
Downer, E. M.
Elliott, F. P.
Estrup, H. H.
Farmer, G. W.
Feldhake, J. M.
Fenn, F. D.
Fitzmorris, Jas.
Fogg, J. W.
Friend, R. O.
Glover, B. H.
Goodwin, G. S.
Goodnow, T. H.
Haig, M. H.
Harvey, L. E.
Hayes, R. F.
Haynes, J. R.
Hibbard, M. W.
Hill, C. P.
Hincher, W. W.
Hinds, J. B. L.
Hodgkins, E. W.
Hopkins, G. H.
Hungerford, L. S.
Jeffries, B. H.
Jenks, C. D.
Johnson, A. B.
Johnson, Geo. C.
Judd, C. W.
Kadish, R. B.
Kucher, T. N.
King, C. H.
Kretchmer, E. E.
LaQuay, M.
Lancaster, J. R.
LaRue, H.
Lee, E. H.
Lewis, J. H.
Lickey, T. G.
Linn, H. R.
Lyman, Jas.
McAlpine, A. R.
McCarthy, M. J.
Manchester, A. E.
Marea, M.
Marshall, Wm.
Meeder, W. R.
Mering, B. G.
Midgley, S. W.
Moody, W. O.
Motherwell, J. W.
Munger, E. T.
Osmer, J. E.
Otley, B. F.
Peck, P. H.
Phillips, L. R.
Postel, F. J.
Ricker, W. W.
Russell, M. F.
Rutherford, F. H.
Ryan, F. J.
Schlacks, W. J.
Schlegell, T. von.
Seley, C. A.
Setchel, J. H.
Sharp, W. E.
Sheppard, John
Sheppard, Roy
Simons, J. E.
Slaughter, H. W.

Smith, W. R.
Speakman, D. H.
Squire, W. C.
Stearns, R. B.
Stimson, O. M.
Stott, A. J.
Stow, H. J.
Street, C. F.
Studer, A. L.
Symons, W. E.
Talbott, Chas.
Tawse, W. G.
Taylor, E. D.
Wallace, W. G.
Taylor, J. W.
Taylor, T. I.
Thomas, C. W.
Thompson, E. B.
Thompson, J. R.
Thurnauer, Gustav
Tinker, J. H.
Towsley, C. A.
True, C. H.
VanTassel, G. D. B.
Vissering, Harry
Wade, E. H.
Waugh, J. M.
Webb, E. R.
West, F. S.
Weston, C. V.
Wheeler, G. W.
Wickersham, R. S.
Wickhorst, M. H.
Winn, C. F.
Woodworth, P. B.
Woods, E.S.
Wright, Wm.
Younglove, J. C.
Zealand, T. H.

THE CHAIRMAN: The first business of the meeting will be the approval of the minutes of the last meeting as printed and distributed. Unless there are objections, they will stand approved.

We will have the report of the Secretary.

THE SECRETARY: Mr. Chairman, I have the membership list as follows:

Membership, January, 1907		1352
Dead	4	
Resigned	1	
Mail returned	3	
Non-payment of dues	5	13
		1339
New members approved by Board of Directors		26
Total membership		1365

NEW MEMBERS.

	Proposed By
W. R. Pierce, Mgr. Revere Rubber Co., 168 Lake St., Chicago, Ill.	Tom Plunkett.
E. W. Farnham, Prest. The Farnham Co., 140 Dearborn St., Chicago, Ill.	J. W. Taylor.
E. R. Hibbard, Prest. Grip Nut Co., 152 Lake St., Chicago, Ill.	R. S. Wickersham.
W. G. Fox, A. C. E. Guraray R. R. Co., Ampata, Ecuador, S. A.	J. W. Taylor.
W. W. Cochran, Railway Supplies, 132 32nd St., Milwaukee, Wis.	J. W. Taylor.
O. S. Hamilton, Chief Car. Insp. C. B. & Q. Ry., Aurora, Ill.	W. A. Derby.
E. G. Schevehell, Div. Supt. C. & N. W. Ry., Winona, Minn.	W. E. Dunham.
Jas. G. Mowry, Repr. Patton Paint Co., Milwaukee, Wis.	G. H. Bryant.
Chas. Hyland, Foreman Boilermaker, M. C. R. R., Michigan City, Ind.	E. R. Webb.
W. F. Dickinson, Griffin Wheel Co., 600 Western Union Bldg., Chicago.	W. E. Sharp.
A. C. Adams, Gen'l Foreman, C. B. & Q. Ry., Alliance, Neb.	S. C. Wheeler.
G. J. Slibeck, Draftsman, C. R. I. & P. Ry., Chicago, Ill.	C. A. Seley.

Geo. S. Goodwin, Chief Draftsman, C. R. I. & P. Ry., Chicago, Ill. .... C. A. Seley.
T. R. Morris, G. F. C. D., C. M. & St. P. Ry., Chicago, Ill. .... J. W. Taylor.
Ray E Gribbens, Asst. Foreman, C. & W. I. R. R., Chicago, Ill. .... P. H. Peck.
Sidney J. Robison, Pullman Co., 6325 Monroe Ave., Chicago .... Wm. Wright.
A. L. Beardsley, Mgr. Cleveland Twist Drill Co., 17 So. Canal St., Chicago .... G. A. Stone.
T. L. Dodd, McClernan & Orr, 1064 Monadnock Bldg., Chicago. .... G. A. Stone.
C. E. Marsh, R. F. E., C. B. & Q. Ry., Galesburg, Ill. .... J. H. Weidenhamer.
F. L. Richmond, G. Y. M., C. & E. I. R. R., Brazil, Ind. .... F. Studer.
F. P. Wilbur, Prest. Automatic Oil Cup Co., 155-157 Huron St., Milwaukee, Wis. .... E. D. Bangs.
E. J. Arlein, Patton Paint Co., 122 So. 52nd Ave., Chicago .... R. B. Kadish.
Percival Hunter, Pur. Dept., C. B. & Q. Ry., Chicago. O. W. Ott.
Chas. L. Brown, Manning, Maxwell & Moore, 6742 Monroe Ave., Chicago .... J. W. Taylor.
H. L. Mann, Loco. Engineer, Wabash Ry., 4534 Forestville, Ave. .... B. H. Jeffries.
E. W. Hodgkins, V. P. L. J. Berdo Co., Western Union Bldg., Chicago. .... W. C. Squire.

DEAD.

H. V. Kuhlman. A. J. Schevers. Frank Clodgio. C. S. Henry.

RESIGNED.

Evan Rees.

MAIL RETURNED.

A. H. Thomas. W. F. Elling. G. C. Johnson.

NON-PAYMENT OF DUES.

J. O. DeWolf F. H. Morse. John Moriarty.
A. E. McLeod. J. B. McLeod.

THE CHAIRMAN: No action is necessary on this.

THE SECRETARY: The Board of Directors having approved the applications, they become members of the Club tonight.

THE CHAIRMAN: The Secretary has a communication to read.

CHICAGO, Feb. 18, 1907.

Mr. J. W. Taylor, Secretary Western Railway Club, Chicago.

MY DEAR SIR: I am this morning in receipt of a copy of the Official Proceedings of the Western Railway Club, meeting of January 15, 1907. The communication from Edwin B. Katte, appearing on page 147, has attracted my attention.

The statements made by me in the meeting of October 16, 1906, having been based upon facts, now contradicted by Mr. Katte, in his letter of December 18, 1906, I ask the members of the Western Railway Club, and others who may read the report of its meeting, to reserve judgment pending adjudication of my rights.

Trusting that in justice to the writer, you will call attention of the Club members to this communication, I am, Very truly,

E. W. FARNHAM.

THE SECRETARY: This communication was presented to the Board of Directors and ordered read in convention.

Mr. Chairman, at this meeting of the Club a committee on "Revision of the Rules of Interchange," in so far as the Western Railway Club has anything to say, should be appointed. At the meeting of the Board this evening, it selected the following members of the Club to act in that capacity:

T. H. Goodnow, M. C. B., L. S. & M. S. Ry.
H. LaRue, M. C. B., C., R. I. & P. Ry.
O. M. Stimson, M. C. B., Swift & Co.
J. W. Fogg, M. M., C. T. T. Ry.
J. E. Buker, A. S. M., Ill. Cent. R. R.

The report of the committee should be presented to the Club at the April meeting and if any members have any suggestions to make as to changes in the Rules of Interchange, please present the same to the chairman of the committee so that it can incorporate the proposed changes in its report at the April meeting.

I would like to say, Mr. Chairman, that at the March meeting of the Club we will have a paper by Prof. Edward C. Schmidt, Associate Professor of Railway Engineering, University of Illinois, entitled "The Heat Transmission Loss Due to Boiler Scale and Its Relation to Scale Thickness." I think this will be a very interesting paper and I give this early notice before taking up the regular order of the evening. Mr. Chairman, those are all the communications I have.

THE CHAIRMAN: The paper of the evening, illustrated by stereopticon views, is entitled, "The Anatomy of a Railway Motor and Control Equipment," by Mr. James Lyman, Engineer Western District of The General Electric Company. I take great pleasure in introducing to you Mr. Lyman.

MR. JAS. LYMAN: Mr. Chairman and Gentlemen: I deeply appreciate the honor of addressing you, representing as you do the brain that maintains and operates the great trunk lines of railroads that center here in Chicago, the greatest railway city in the world. No branch of engineering is more worthy of respect. The steam railroad has been and is the most potent influence in developing and building up this country of ours into the strongest, noblest and most influential nation in the world.

It has been said that the successful electrical engineer is 95 per cent mechanical and 5 per cent electrical. With the rapid introduction of electric power to railroading as well as other lines of engineering work, I will add that the successful civil engineer, mechanical engineer and master mechanic, from now on, should have the 5 per cent electrical engineering.

I have been asked to speak to you on "The Anatomy of a Railway Motor and Control Equipment." For the benefit of those who have not given the subject attention I will briefly give some of the

fundamental principles governing electricity and magnetism on which the action of the motor depends.

Magnetism.

You are all familiar with the horseshoe magnet and the attractive force which it exerts on iron. One end will attract a compass needle, and is called a north pole and the other end will repel a compass needle and is called a south pole. If a current of electricity is passed through a coil of wire wound over a piece of iron, the iron becomes strongly magnetic.

I have here a horse-shoe magnet and you will notice the pull it exerts on these nails. I also have a bar of soft iron bent into a "U" shape which exerts no magnetic pull at present, but by slipping this coil of wire over it and passing a current of electricity through the coil by closing the switch you will see the iron has been transformed into a strong magnet and it will remain so as long as the current is flowing. This is called an electro-magnet and exerts a much stronger pull than a permanent steel magnet.

The electric motor is an ingenious application of this magnetic pull exerted between two electro magnets, one of which is a fixed horseshoe magnet called the field and the other is a movable magnet in the shape of a round iron core mounted on bearings capable of revolving called the armature.

Each is made a magnet by a current of electricity passing through a coil of wire wound around its surface. By means of a device called the commutator, the current flowing in the armature polarizes the iron in a direction at nearly right angles to the polarization of the field so that a powerful pull or torque is established between the two tending to rotate the armature and bring its polarization into line with the polarization of the field. As the armature revolves, however, the commutator changes the leads through which the current enters the armature winding, polarizing the armature in a direction opposite to its rotation, and thus maintaining the relative pull or torque regardless of the speed at which the armature revolves.

The commutator is simple in its construction. It consists of an assembly of copper blocks or bars mounted on a spider or armature shaft. The bars are insulated from each other. Each bar is connected to the armature winding by a lead wire. The current is brought to the commutator through rubbing contacts called brushes, the brushes being supported in insulated brackets.

The electric current is carried to the armature winding through brushes which make sliding contact with the commutator bars. From the bars the current passes through the leads into the armature winding. The brushes are held in a fixed position and are always in contact with the opposite commutator bars. The current thus flowing through the brushes into the armature winding is divided,

one-half passing through one branch of the winding and one-half through the other. It polarizes the armature core vertically or at right angles to the polarization of the field magnet. As I close the switch the current flows into the armature and produces the above polarization and the armature starts to revolve. As each succeeding lead comes into the vertical position it comes into circuit and thus the polarization is maintained always at right angles to the polarization of the field and so a continuous torque is applied to the armature.

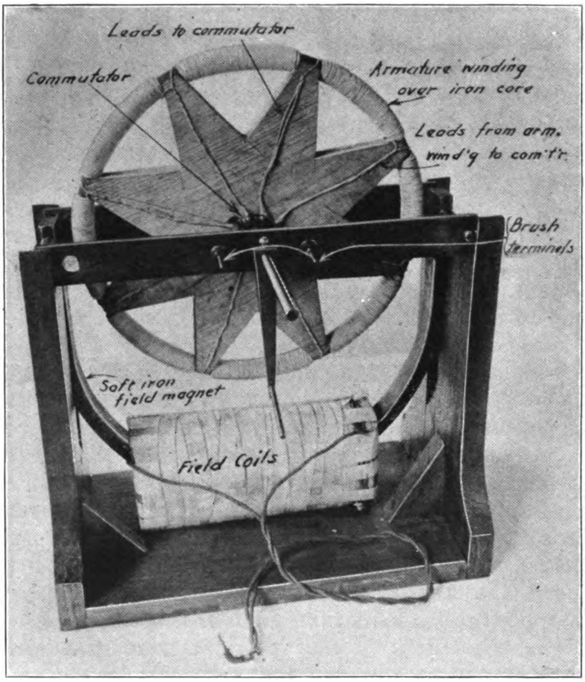


Fig. 1.

A reversal of either the field terminals or armature terminals will cause the armature to reverse its direction of rotation. There is in the armature circuit an ammeter which indicates the flow of current into the motor.

We will now put a crank on the extended armature shaft and with the field excited rapidly rotate the armature. You will note by the ammeter that the armature is now delivering current to the circuit as a generator. The mechanical energy delivered is trans-

formed into electrical energy instead of electrical energy being transformed into mechanical work, as was the case when the machine was running as a motor.

Before revolving the armature by hand, it was necessary to reverse the armature terminals to get a positive reading on the ammeter, because the current flows in the opposite direction when the machine is running as a generator than running as a motor.

The model which I have here is made up to show the essential elements of the motor and how the electric current, by means of its magnetic effect on the iron causes the armature to revolve. The model is not designed for work or economy. At first sight it bears little resemblance to the commercial railway motor, but if we examine the latter we will find all the essential elements embodied in a design very compact, powerful and efficient. We will see the commercial railway motor on screen later.

The torque developed depends upon the magnetic strength and size of the field poles and the magnetic strength and size of the armature. The magnetic pull exerted by the field of an ordinary railway motor is from five to seven pounds per square inch, while in some cases, as the New York Central locomotive, it is as high as fourteen pounds per square inch. You will notice with these permanent magnets the pull is comparatively light, it will be measured in ounces rather than pounds. The speed depends upon the number of turns of wire on the armature, the magnetic strength of the field poles, and the electro-motive force or voltage of the electric circuit.

Electricity.

Electricity is a form of energy; heat is a form of energy, and energy is represented in a moving mass as falling water or a moving train. Each of these three kinds of energy has its own units of measure and each can be readily transformed into either of the other kinds of energy. The unit of heat is the B. T. U., which is the heat required to raise one pound of water one degree F. The unit of mechanical energy or mass in motion is the energy necessary to raise one pound one foot against the force of gravity and is called the foot pound. The rate of doing work is measured in H. P. 550 ft. pound per second equals 1 H. P.

Electricity is measured in volts which corresponds to pressure and in amperes which corresponds to rate of flow. The rate of expenditure of electrical energy is the product of volts and amperes which is called watts. The kilowatt is the common unit, commercial unit. Seven hundred forty-six watts is equivalent to one H. P. One thousand watts equal one kilowatt or 1 1-3 H. P.

All substances offer a certain resistance to the flow of electricity through them. Some offer an infinite resistance and are called non-conductors or insulators, as mica, varnished paper cambric,

porcelain, glass, etc. Others, as the metals, offer little resistance and are called conductors. Copper, silver and aluminum are the best. Copper wire is about ten times as good a conductor as iron wire and thirteen times as good as german silver. Copper wire with some insulating covering is universally used for winding electric machinery and for distribution circuits. It has a certain amount of resistance to the flow of current exhibited in heating the conductor. It is easy to transform all the electrical energy into heat by using a high resistance wire. The commonest examples are the car heater and incandescent lamp.

In the case of car motors and control equipment the problem is to transform as little of the current into heat and as much of it into mechanical tractive effort at the car wheels as possible. Besides the resistance loss in the armature and field coils of the motors there is a small loss of energy in the iron. Iron offers a certain resistance to magnetization and in the rotating armature where the iron is rapidly changing its magnetization this loss is appreciable.

In a well designed railway motor the losses are approximately as follows at free running speed:

Copper losses	4%
Iron losses	6%
Gear and bearing losses	10%
Total	20%

leaving a total efficiency of transformation from electrical to mechanical tractive effort of 80 per cent.

During acceleration the distribution of losses is about as follows:

Copper losses	10%
Iron losses	2%
Gear and bearing losses	5%
Total	17%

leaving a total efficiency of transformation from electrical to mechanical tractive effort of 83 per cent.

If, as I have just stated, the loss of electricity due to resistance or friction of the armature and field winding is only 4 per cent, what prevents twenty-five times as much current flowing into the motor, or enough to absorb all the current in heat, just as in the case of an incandescent lamp. To explain this I must call your attention to the action of the motor running as a dynamo generating an electric current, I will excite the fields of this machine and revolve the armature by hand. You will note by the ammeter that an electric current is generated in its winding. Run as generator the action is exactly the reverse from that which took place when the machine runs as a motor. As the armature revolves, the polariza-

tion of its iron core changes, and the coils of wire surrounding the core have an electro-motive force generated in them.

The fundamental relation between electricity and magnetism is that if a coil of wire is moved through a magnetic field, an electro-motive force is induced in the coil, and a current of electricity will flow, depending on the resistance of the circuit; and vice versa, if a current of electricity is passed through a coil of wire, a magnetic field is established around the coil. If the coil of wire is wound over an iron core, the iron is made a magnet or polarized.

Referring to our dynamo driven as a generator, the electro-motive force or voltage induced in the winding depends on the strength of field and the speed of the armature. When the dynamo is driven as a generator, the current flows through the armature winding in one direction. When the same machine is run as a motor, the current flows in the opposite direction. In the first case it flows out of the machine and in the second case it flows into the machine.

The generator action really takes place in both cases. The current flowing into the armature causes it to revolve as a motor, but in revolving in the magnetic field an electro-motive force is induced in the coils equal and opposite to the line voltage of the current flowing into the motor less the resistance loss in the winding. It is this "opposite or counter electro-motive force" that prevents the unlimited flow of the current into the motor.

This, however, is only true when the motor is up to speed. When it is starting, there is no counter electro-motive force, and a substitute must be supplied to throttle the current. A coil of high resistance wire or a collection of cast iron girds called a starting rheostat performs this function. In railway work a collection of these rheostats is arranged so that as the motors come up to speed these rheostats are short circuited one after another.

A motor may be designed to give constant speed through a wide variation of load by connecting the field circuit directly across the line. In this case the strength of the field is kept the same, and the motor torque is varied by the current taken into the armature. This type is called shunt motors.

Motors may be designed for variable speed by connecting the field coils in series with the armature coils. These are called series motors, and are especially well adapted for railway work, because at starting they can develop five or six times the torque required of them when the train is running up to speed. This results in splendid train acceleration. The reason for this high torque is that all the current passing through the armature alone passes through the field and magnetizes both the field and the armature to their maximum, and hence gives maximum torque. As the motors come up to speed, the torque required naturally decreases and the counter electro-motive force in the armature increases, automatically, reduc-

ing the current flowing; thus weakening the magnetization of the field and armature.

A series motor does not require as much throttling as a shunt motor at starting. Another ingenious scheme is used in railway practice, which also reduces the amount of starting resistance required; namely, to connect at starting two motors in series, so that the same current goes through both motors. They will then each only receive one-half the line voltage, and only tend to run half speed. When they have come up to half speed, the connections are changed by switches, so that each motor gets independent current, and so continues to accelerate up to full speed. When connected so that the same current goes through both motors, they are said to be in series. When connected independently they are said to be in parallel.

The power requirements for street car work have rapidly increased with the increase in size of cars and speed conditions from two 25 H. P. motors per car to four H. P. motors per car, and for interurban work four motors are generally used, ranging from 50 to 100 H. P. capacity each. To handle this heavy power, giving smooth acceleration and reliable and absolute control, special design of all switches and auxiliary apparatus has been necessary.

Distribution of Electric Power.

As stated above, the best conductors offer a certain amount of friction to the flow of electric current. This friction loss varies directly as the square of the current, and is entirely independent of the voltage. Therefore the loss to transmit a given amount of power at say 500 V. over a given conductor will be only one-quarter as great as to transmit the same power over the same conductor at 250 V. In providing for the heavy power requirements for a city traction system or a railroad, it is, therefore, desirable to adopt as high a line voltage as can be safely handled by the apparatus, and at present 600 V is the standard. Trolley wires of 3/0 copper reinforced by 500,000 C. M. cable feeders are usually used with an average loss ranging up to 10 per cent. With very heavy equipments where the power taken per car runs up to a maximum of 400 to 500 H. P., the trolley wheel which takes the current from the trolley to the car has reached its limit, and the third rail is necessary. This is the case with our elevated roads, and also with the electrical equipment of some steam roads, as the New York Central. A railway equipment must not only be reliable but it must be fool-proof; that is, in the hands of the unskilled labor it cannot be easily injured. Space is exceedingly valuable; therefore, it must be as compact as possible.

SLIDES.

I will now briefly review the theory we began with. Fig. 2 is an armature and dynamo which is made up exactly like the model. You will note the armature core, the armature winding, the leads

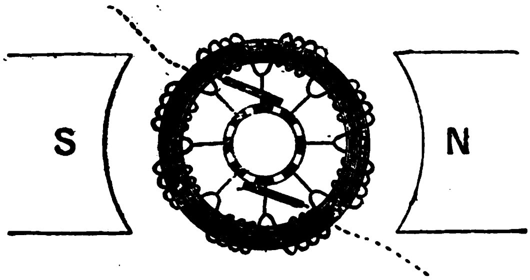


Fig. 2.

from the armature winding to the commutator bars or segments, the brushes connecting the moving commutator with the external circuit, the field poles and field coils. This design of armature is called the ring type. It is now seldom used.

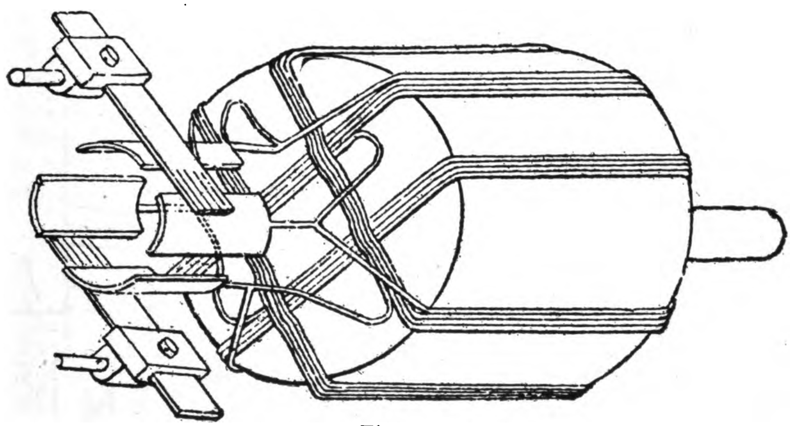


Fig. 3.

Fig. 3 shows a drum type armature. This or some modification of it is used for nearly all motors and generators. It is quite similar to the winding on a regular railway motor; instead of having a large number of commutator bars, Fig. 3 shows only four, but the connections are just the same. The armature core is a solid mass of iron, or rather, it is made up of thin sheet iron punchings, each having a thin coat of insulation paint to prevent flow of electric current through the mass of iron itself.

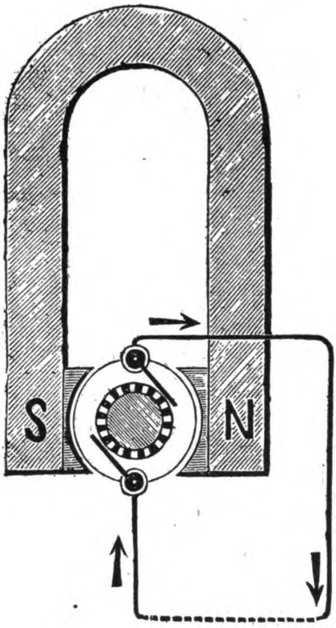


Fig. 4.

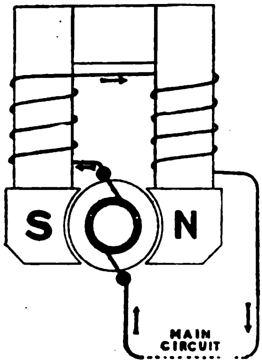


Fig. 5.

Fig. 4 is another illustration of the simplest form of motor. You will note the field is a permanent horseshoe magnet without a field coil. These are frequently used for telephone magnetos.

Fig. 5. This is the typical railway motor, the same current flowing through the armature and the field.

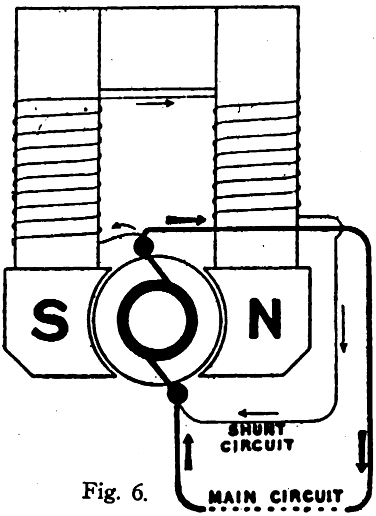


Fig. 6.

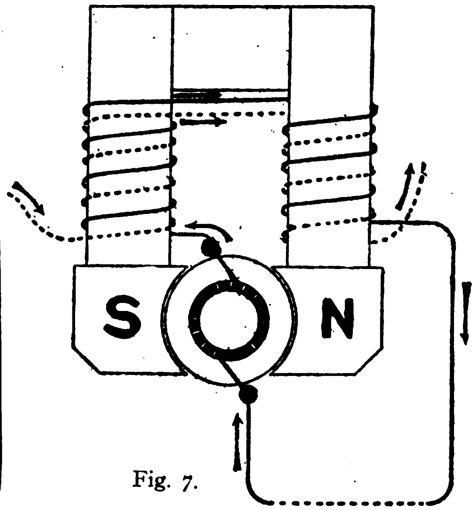


Fig. 7.

Fig. 6 is a shunt motor. The main current does not go through the field, but only a certain small portion is sidetracked or shunted through the field.

Fig. 7 shows a motor with compound field winding—the main

circuit makes several turns around the field, partially magnetizing same, and there is also a shunt circuit. These three classes represent the three different types of direct current railway generators and motors in practice. Of course these are mere skeleton forms.

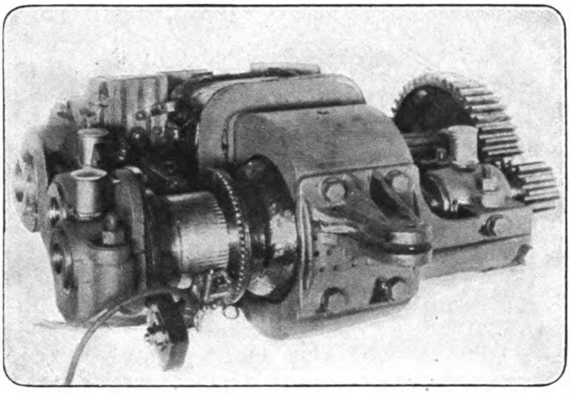


Fig. 8.

Fig. 8 is the F 30 Sprague railway motor, now a historic machine, for it was one of the first used in railway work and an exceedingly good one for its time. You will recognize some of the essential features—the horseshoe magnet and the field coils, the armature and the commutator, having a large number of bars or segments to take care of the high voltage that is used:

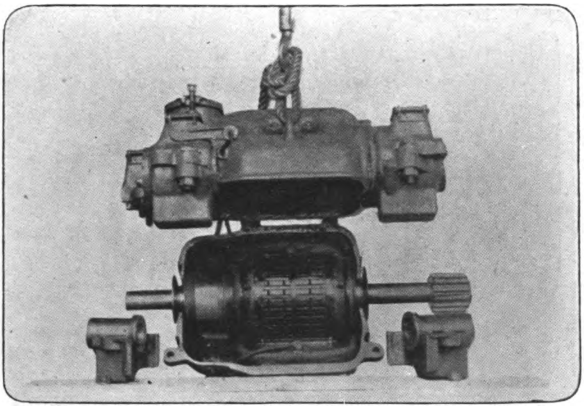


Fig. 9.

Fig. 9 is a 40 H. P. modern railway motor, designed to occupy the limited space in the trucks. We have lost the horseshoe mag-

net, but we have magnetic circuits which are as good and more effective.

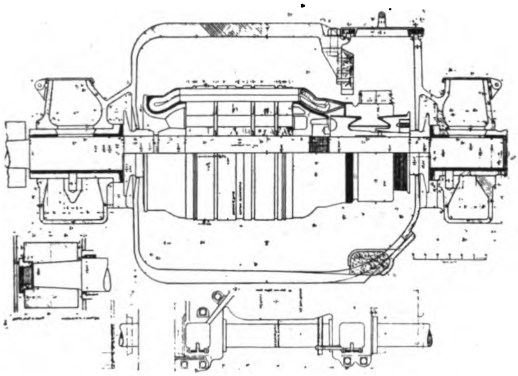


Fig. 10.

Fig. 10 shows a sectional view of another motor that is used in regular railway service. This is a 60 or 75 H. P. motor. You see the commutator, supported on an iron spider, thoroughly insulated from same, and sections of the armature winding, the winding being imbedded in slots in the iron core, the iron core becoming just as true a magnet as if it were a horseshoe magnet. The fields, which you cannot see, lie within the frame casting.

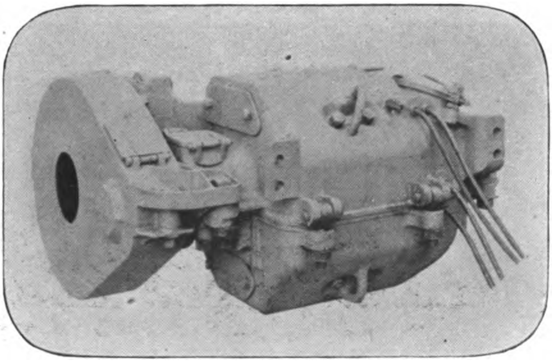


Fig. 11.

Fig. 11 shows the commercial motor as we are accustomed to see it on the street car, entirely enclosed so that street wash cannot get into the windings.

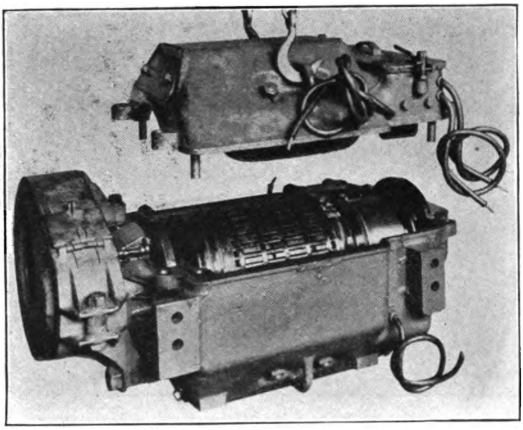


Fig. 12.

Fig. 12 is another view showing similar construction.

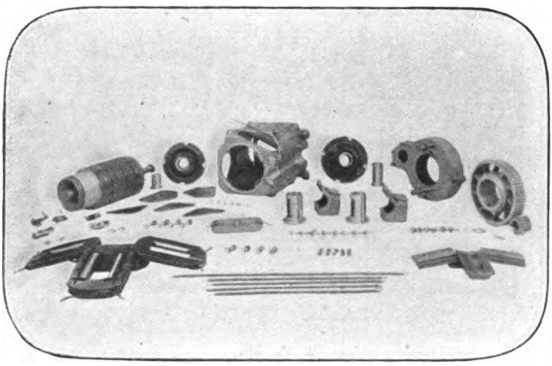


Fig. 13.

Fig. 13 shows the dismantled parts of a railway motor.

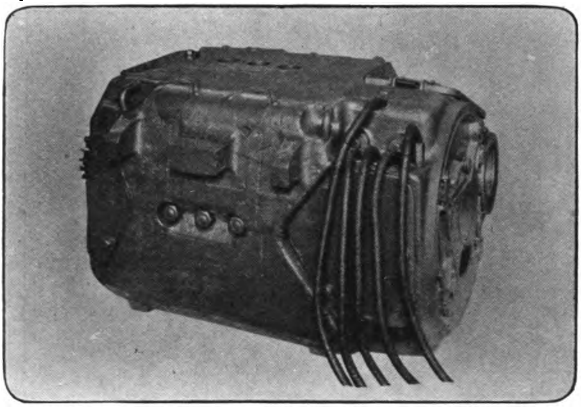


Fig. 14.

Fig. 14 is a 200 H. P. motor used on the Interborough Railway in New York City and also on the New York Central suburban service, two motors per car.

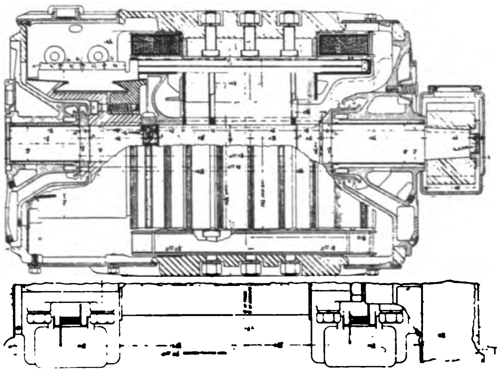


Fig. 15.

Fig. 15 shows a section of this motor, indicating the compactness of the design.

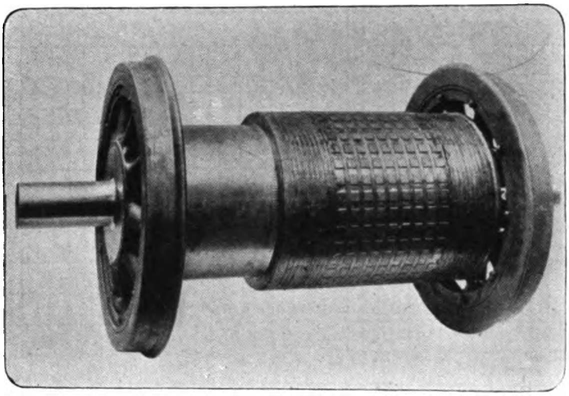


Fig. 16.

Fig. 16 is an armature assembled on the driving wheel axles of the New York Central locomotive.

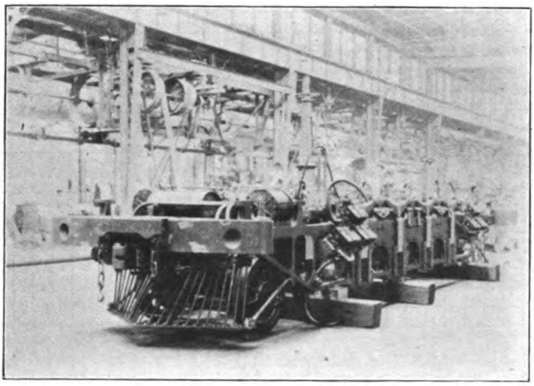


Fig. 17.

Fig. 17 shows the truck of the New York Central locomotive assembled ready for the car body. You can see some of the parts, the air brake equipment, etc.

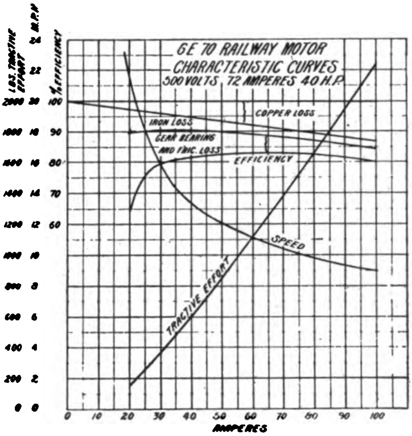


Fig. 18.

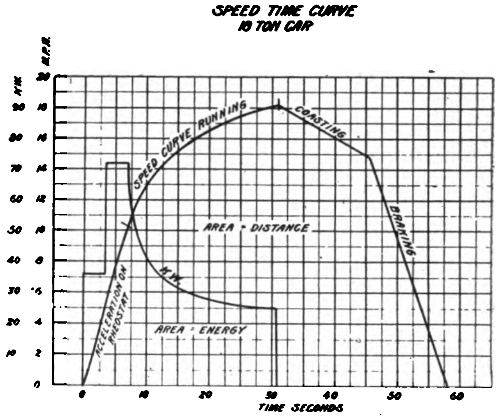


Fig. 19.

Fig. 18 gives the characteristics of a 40 H. P. railway motor. The copper, iron and friction losses are shown between the efficiency curve and the upper horizontal line. The curves showing tractive effort and speed in miles per hour under varying load conditions are also shown.

Fig. 19. The speed curve is interesting as it shows the acceleration

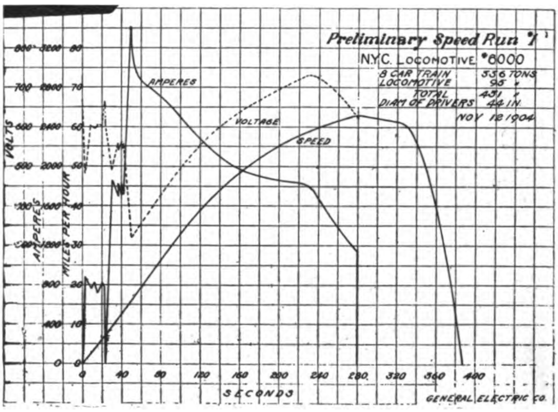


Fig. 20.

of the car. The smooth curve represents the speed curve. The irregular curve represents the electrical energy input and the energy input. The speed curve shows that the car covers about 400 feet, or one block, in one minute. The energy curve shows the motors are connected in series for 1½ seconds, then in parallel, the car reaching

free running speed in 30.5 seconds. Then the current is turned off and the car coasts for six seconds. Then the brakes are applied for five seconds when car is brought to a stop. The car reaches a maximum speed of 18 miles per hour. The distance covered is determined by dividing the speed curve area by 60x60, the sections being in seconds.

Fig. 20 is a similar curve showing the speed curve taken with the first test run on the New York Central locomotive. The power runs up at the starting to something like 3,000 H. P.

Fig. 21 is a curve taken of the same locomotive showing the starting; starting first with an eight-car train and then starting with a four-car train. The speed curve shows the acceleration 50 per cent higher with the four-car train. Exact determination can be made from the electrical instruments showing what the locomotive is doing.

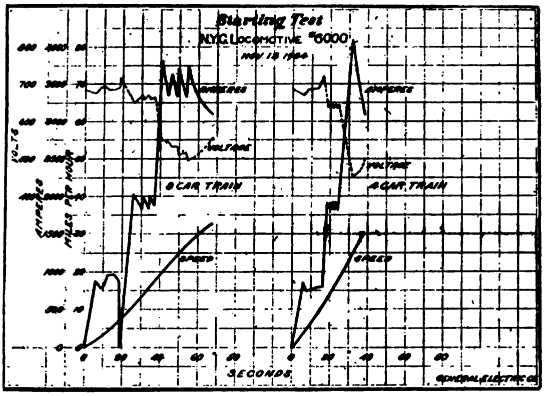


Fig. 21.

It was a very difficult matter at first to design a system of switches and rheostats that would reliably control the current taken by the motors so as to get smooth acceleration and not injure the motors. Fig. 22 shows the various methods and stages by which the motors are connected. First, when a car is started the two motors (assuming this is a two motor car) are put in series. The curved line represents the field wiring and the small circles the motor armatures. The current flows from the trolley first through the field and the armature of one motor, then through the field and armature of the other motor to the ground. When the car has attained half speed the connections are changed, so that the current passes directly from the trolley through each motor field and armature direct to the track. This doubles the applied voltage on the motors, and they

rapidly accelerate to full speed. Four-motor equipments are connected in pairs.

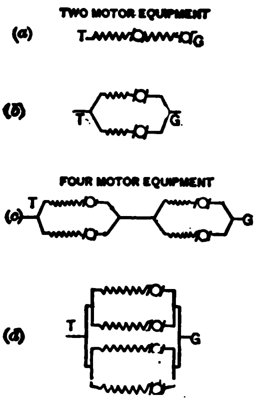


Fig. 22.

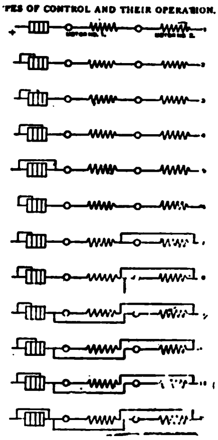


Fig. 23.

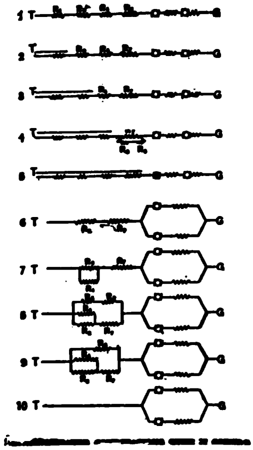


Fig. 24.

In the previous diagram no apparatus was shown for throttling the current just at the point of starting. This is necessary, or the motors would be burned out. Fig. 23 shows the blocks of resistance that are cut into the circuit in sections used only for a few seconds during acceleration.

Fig. 24 is another diagram which shows the arrangements of resistance for train control. The resistances are individual re-

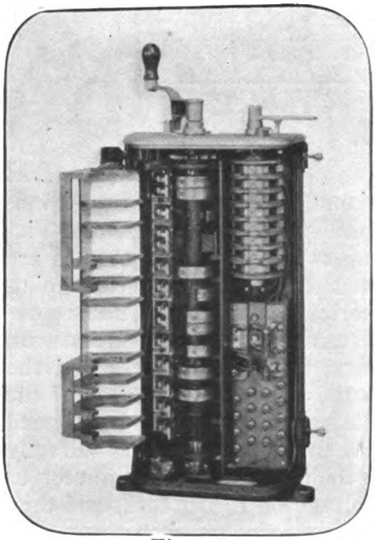


Fig. 25.

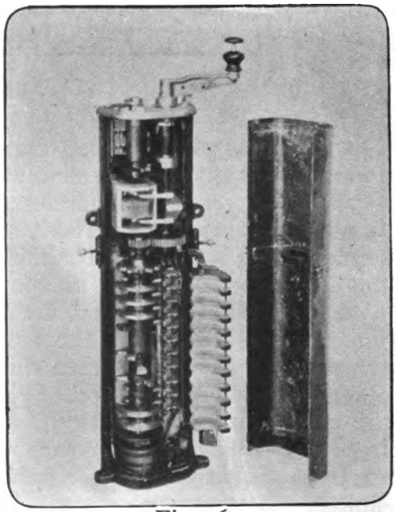


Fig. 26.

sistances and are arranged somewhat differently for mechanical purposes. The different combinations are indicated. Fig. 25 shows a controller or series of switches, which give all of the various combinations necessary for an ordinary street car equipment such as we have here in Chicago. This controller is used on all the new cars in the service of the city railway company, and is known as the K-28. The little fingers are the switches; there are contact parts on the cylinder which revolves by hand and as the fingers make and break over these contacts they make the necessary connections shown in the above diagram.

Fig. 26 is a controller used on a heavy train. It is impracticable on heavy train work to take the main current through the controller. The little fingers have not sufficient capacity to break the current, so special individual switches are used, mounted together in a box under the car body, and a control circuit taking only a very little current is used to operate them. The above controller handles only this control current.

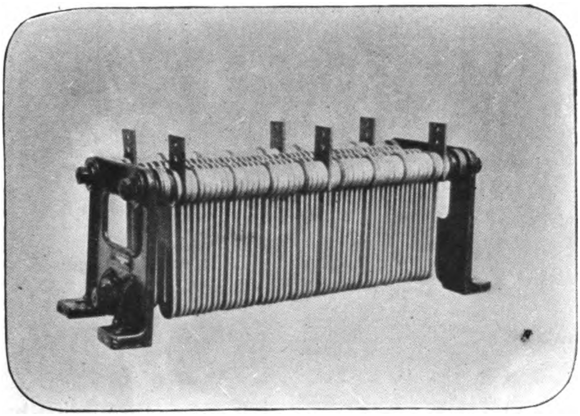


Fig. 27.

Fig. 27 is a type of resistance that is used. It is a collection of iron girds that are electrically connected together at certain points, so as to give the desired throttling effect on the current that is required during starting.

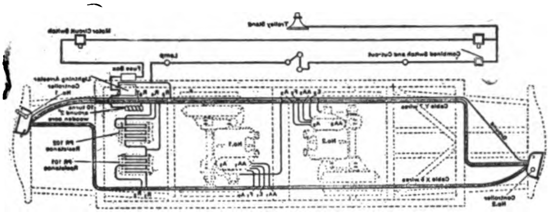


Fig. 28.

Fig. 28 is a car wiring diagram which illustrates about the way the cables and apparatus are located on the floor plan of the car. You can see the car axles and wheels in the dotted lines and the motors in the dotted lines and the main cables connecting with a controller at each end so that the car can be operated at each end. The resistances are seen at one end of car.

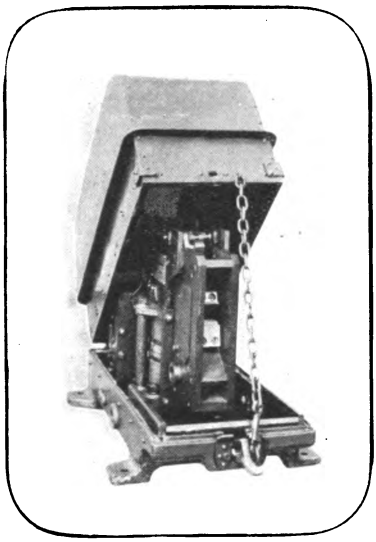


Fig. 29.

Fig. 29 shows an automatic switch that automatically opens the circuit in case of a dangerous overload, either due to excessive flow of current or from any other cause. The contact and magnetic blow out feature are seen. An electric arc in the presence of a magnetic field is affected as if a high pressure draught of air were directed upon it, extinguishing the arc instantly. In the above circuit-breaker the circuit passes several times around an iron box which is magnetized strongly, and when the switch opens the magnet field established blows out the arc with almost an explosion.

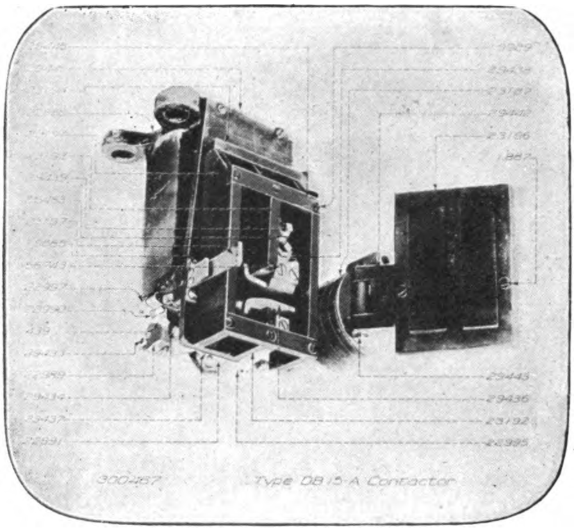


Fig. 30.

Fig. 30 shows one of the individual switches on a train, a heavy train control. This is the switch proper and it is operated by a coil of wire that is not seen; it is enclosed in this iron frame work.

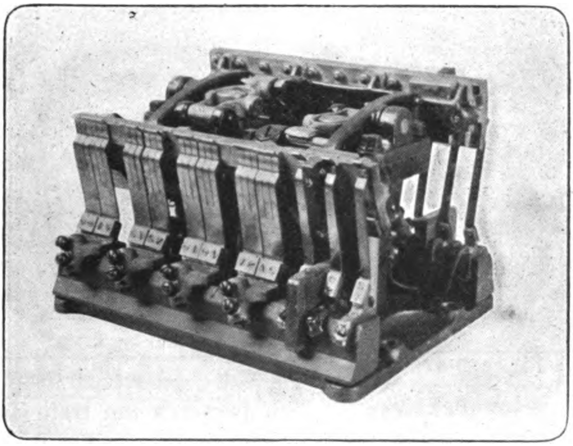


Fig. 31.

Fig. 31 is a reverser for reversing the armature leads, which reverses the direction of rotation of the motors and hence the motion of cars.

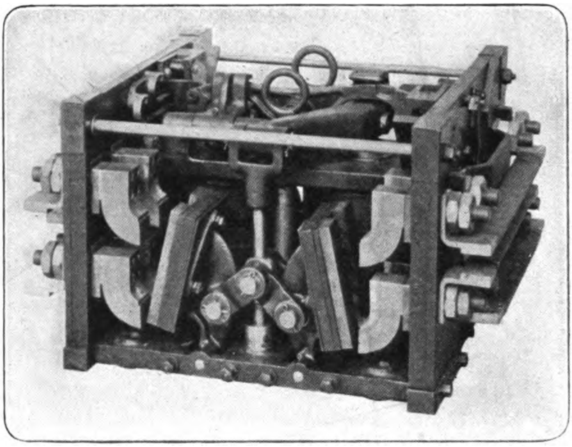


Fig. 32.

Fig. 32 is another type of the same reverse switch.

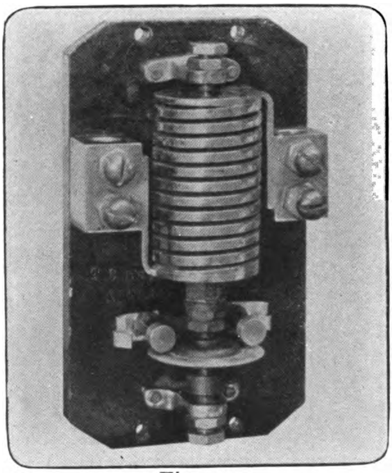


Fig. 33.

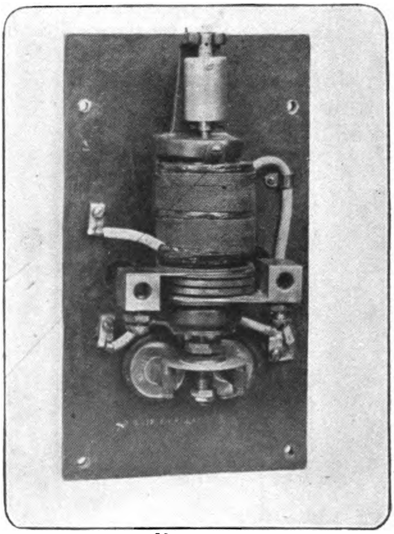


Fig. 34.

Fig. 33 is another device which prevents the train from taking more than a certain determined normal current during acceleration. The current passes through the coil, producing a magnetic field inside of it and pulls this iron core up, making contact, or opening the contact with the control circuit, which in turn actuates the main switches.

Fig. 34 is another form of a controlling switch that opens the main switches in case the line voltage fails.

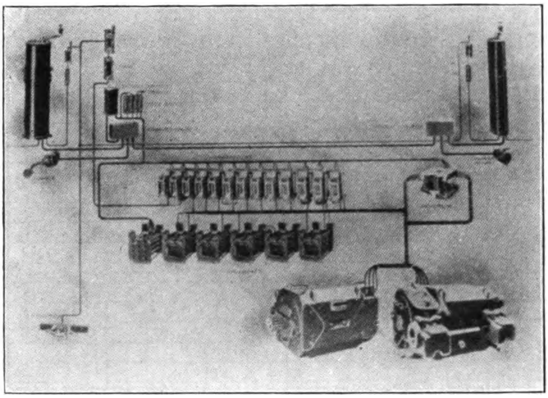


Fig. 35.

Fig. 35 is a diagram showing the arrangement of all the apparatus for one of these train controlling equipments, the master controller being placed at either end of the car. The resistances are located here under the car. Each of the switches that need to operate for making the different connections are all operated through the control circuit that comes from the master controller at one end of car. The circuits from these switches are shown.

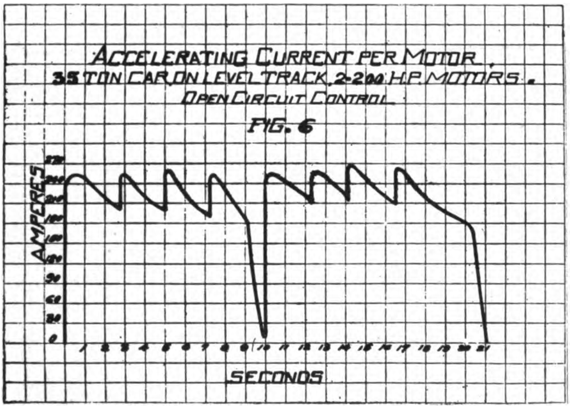


Fig. 36.

Fig. 36 shows the accelerating current per motor of a 35-ton car with two 200 H. P. motors. It is operated on what is called an open circuit control. This would be similar to the New York Central suburban cars and it shows how the current is throttled, so that

it cannot rise above a certain amount. You will note that in changing from series to multiple, the current is cut entirely off.

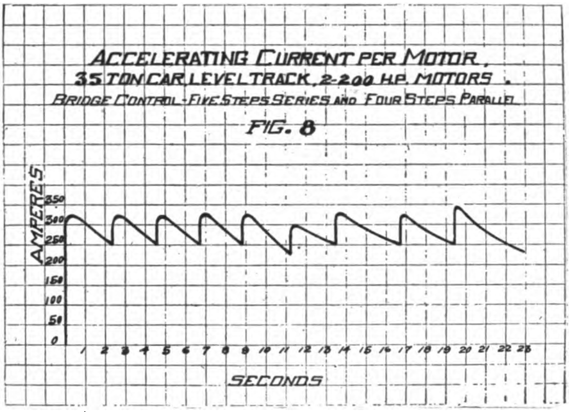


Fig. 37.

Fig. 37 shows an exactly similar condition where a slightly different type of connections is made, called the bridge control, which is now standard, and used by practically all of our railroads in which the current is maintained during acceleration at almost uniform amount from the start, up to full parallel.

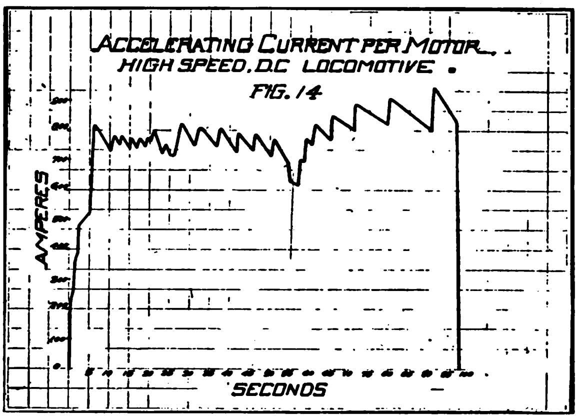


Fig. 38.

Fig. 38 is a locomotive acceleration current curve showing the same method of control while the current changes slightly, yet it is very gradual and the acceleration is very smooth.

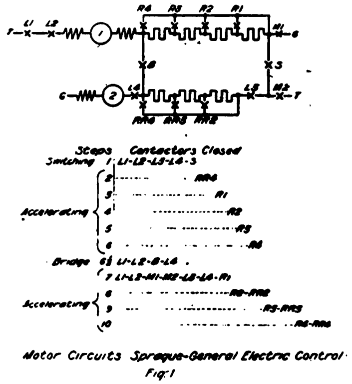


Fig. 39.

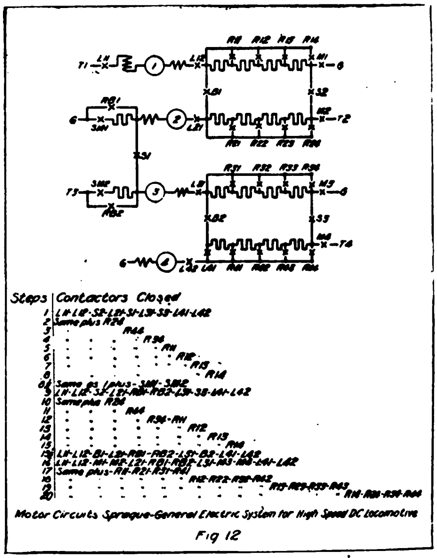


Fig. 40.

Fig. 39. This diagram shows the connections for bridge control. The current is never cut off, but when the motors pass from series to parallel switch B is closed and the circuit is never opened.

Fig. 40 is another diagram showing practically the same arrangement on a heavier service, a four-motor controlled service.

Thus far in this discussion I have spoken only of railway motor and controlling equipments. Now, if the light may be turned on, I will speak of Train Control.

There are two general types of train control; one manufactured by the General Electric Company which is operated by a special control circuit; the other manufactured by the Westinghouse Electric & Manufacturing Company is operated by compressed air. I will briefly describe the G. E. type M Control. This is designed to control both single cars and trains. The system is adapted to either single cars of a capacity too great for the cylinder controller or to all types of cars which may be possibly operated in a train. Circuits are arranged in such a manner that when a number of cars are coupled together motors may be operated collectively and simultaneously from either end of any car. The cars composing the train may be coupled in any desirable relation with each other, and every motor will at all times perform its equal share of the work.

The multiple unit system may conveniently be divided into two parts, the first consisting of a controller composed of a number of electrically operated switches, called contactors, which take the place of the ordinary cylinder controller and may be considered as a more

refined development of such, designed to handle currents of too great magnitude. The second part comprises a master controller, the function of which is to operate the contactors and a system of cables which extend the length of the train, thus placing in multiple all the motor controllers. The control cables are provided with couplers between cars and proper connection boxes.

The apparatus for each equipment consists essentially of master controllers, train cable and couplers, two sets of contactors with a box for each, a set of rheostats, reverser, trolleys and lightning protective apparatus. A powerful magnetic blow-out is provided on these contactors. The function of the contactor is to change the electrical connections in such a manner as to establish proper motor connections for accelerating, running and reversing. Each contactor consists of an electrically operated switch depending on a solenoid for its action. Each contactor is provided with an arc chute. The contactors are assembled in a box with an iron frame and a sheet iron cover. The box is designed for use in connection with conduits having suitable entrances for the main cables and connection boxes for the control cables.

In this discussion I have spoken only of D. C. railway motors and control equipment. Several types of alternating current motors have been experimentally tried for railway work and at the present time the only one in commercial service in this country is of substantially the same design as the direct current motor, namely, a straight series type of motor. Much of the control equipment is identical.

The object in the use of alternating current motor is that it permits of using a trolley voltage many times higher than is permissible in direct current trolley voltage, thus permitting heavy power to be transmitted over long distances of railroad with high economy. It is beyond the scope of this paper to consider the relative merits of the A. C. and D. C. motor equipments. They each have their special field.

To any one desiring reference books on first principles, I would recommend the following:

Mann & Twiss Physics.

Practical Electricity, published by the Cleveland Armature Works.

Ashe & Keiley—Electric Railways.

Alternating Current Engineering, by E. B. Raymond.

Dynamo Electric Machinery, by S. P. Thompson.

For general reading the Electric Railway Journals.

The electric railway motor has reached a point of development where it can advantageously replace the steam locomotive for much suburban service, and in certain instances for through passenger and freight service where traffic conditions are especially congested. It offers all the reliability of the steam locomotive with the following advantages:

First: From 50 per cent to 100 per cent increased train capacity with the same track facilities. In suburban work this is obtained by multiple unit train service dispensing entirely with a locomotive, as is done on the Elevated Railroads. The combined tractive effort of the motor cars during acceleration is from three to four times as great as with steam. The length of trains is only limited by the station facilities.

Being operated from either end the station terminals need not provide turn-table, switch track, roundhouse, etc., and no time is lost in sending trains out. Due to the increased acceleration a much higher scheduled speed with the same maximum speed can be made. In the case of through train service electric locomotives are used.

A number of instances are now under consideration for the electrification of considerable sections of railroads in the West with a view of increasing their capacity for handling traffic without increasing the tracks. In one case with an investment of about 30 per cent of the cost of double tracking the road for the electrical equipment, including power plant, the capacity for handling trains will be doubled.

Second: Convenience, cleanliness and general comfort of passengers, combined with the increased schedule speed and frequency of service, the freedom from smoke, cinders and bad ventilation greatly stimulates travel. This has been demonstrated in the enormous growth of interurban railway service.

Third: Safety. Without the locomotive boilers under high steam pressure and a great mass of white hot coal in the fire box, the horror of fire in case of train wreck is avoided. While by heating and lighting cars by electricity the most perfect ventilation, illumination and uniform temperature is obtained.

Fourth: The economy of operation. The awakening of interest in the electrification of steam roads is due primarily to the successful development of suitable motors and control equipment for an improved railway service. The recent advances made in power house economies and improved power transmission and distribution have also materially contributed to the advance. Today steam power houses are generating electric power for one-half the pounds of coal per H. P. as required by the locomotive, and the coal used is of a much lower and cheaper grade. The power is transmitted many miles with exceedingly small losses, so that the savings alone in power largely offsets the interest and depreciation charges on the capital invested in the electrification. There are other important economies in electric operation, namely, the elimination of cleaning boilers, roundhouse expenses, and material reduction in the cost of repairs, also entirely doing away with the expense of coaling, watering and ash handling. Further, an electric locomotive due to the above facts will cover at least 25 per cent more miles per month

than the steam locomotive. The additional mileage reduces the train crew expense per mile. Further, from 15 per cent to 25 per cent of the total weight of the train is reduced by the use of an electric locomotive due to the fact that all the weight is on the drivers. Indeed, with electric locomotives in many cases, it is necessary to add ballast to obtain the desired adhesion.

In the electrification of steam roads the net earnings are increased by the economies enumerated above in operation, but the net earnings are increased still more by the increased capacity for handling passengers and freight. In other words, the gross receipts.

Fifth: The miles per hour at which a steam locomotive can maintain its maximum tractive effort is a function of the boiler capacity, namely, for freight locomotives from 9 to 10 M. P. H. The electric freight locomotive can maintain its maximum tractive effort continuously at approximately double the above speed, thus permitting of double the tonnage hauled in a given time. This feature is brought out in a paper by A. H. Armstrong, on "Electricity versus Steam for Heavy Haulage" (Street Railway Journal, Vol. XXV., page 820, for May 6, 1905), where the following table is given:

HAULAGE CAPACITY AT VARIOUS SPEEDS.

Miles per Hour.	*Steam Tons.*	*Electric Tons.*
10	1,450	1,380
15	1,140	1,380
20	850	1,380
25	650	1,380
30	530	1,380
35	430	1,380
40	360	620

The New York Central electric locomotives, which were not designed for switching purposes, have demonstrated their ability to handle four times the amount of switching in a given time as the steam locomotives now in use for this purpose.

Sixth: The ability to safely maintain higher speeds than it is possible or safe to do with steam locomotives. The center of gravity of the electric locomotive is down close to the trucks. The applied torque is uniform as contrasted with the reciprocating motion of the steam locomotive parts, so that the hammer blow on the rails is eliminated and there is no tendency for the wheels to leave the track. Experimental motors are now being designed for express service with a maintained maximum speed of 90 miles per hour.

Seventh: If the question was: The replacement of steam locomotive by the electric locomotive for accomplishing the same service, we would be reluctant to consider the change, even though a considerable economy was obtained, but the fact is the electric locomotive can do what it is impossible for the steam locomotive to do, and

its introduction marks a distinct step in advancement in railroad transportation.

WATER POWER.

I have spoken of the economy in power production and distribution from steam central stations.

The great water powers of this country are now rapidly being developed and the cheap power thus produced will be a potent factor in the electrification of steam railroads. It is an interesting fact that to-day Niagara Falls' power extends more than half way across New York state and meets the Hudson River water power in the trolley wires of the interurban railway paralleling the New York Central, a total distance of over three hundred miles.

As the cost of coal increases, these great natural and perpetual power supplies will be called upon to operate not only the manufacturing industries and light our cities, but drive and operate the trains now propelled by steam.

We have here in Chicago the highest development in steam power house. I refer to the Fisk Street Power House of the Commonwealth Electric Company. At present it has a maximum capacity of over 100,000 electric H. P. in 8 Curtis Turbine units. When two additional units soon to be installed are in service, its maximum capacity will be 140,000 H. P., the largest power house in the world.

From this power house current is delivered to all the Elevated Railroads in Chicago, with the exception of the South Side Elevated, to the Chicago Union Traction—Chicago City Railway Company, to the Illinois Tunnel Company, and to the Lighting & Power distribution throughout the City of Chicago, over an area of 65 square miles. It is contracted to furnish power to two interurban railroads running more than forty miles out of Chicago. From this same power house current might most economically be furnished for operating the suburban service of all the steam railroads entering Chicago.

In conclusion, I beg to quote the following from Mr. C. F. Daly, Passenger Traffic Manager of the New York Central Railroad, regarding their high speed locomotives:

"The electric locomotive for the New York Central Railroad is the most powerful locomotive using either steam or electricity in the world. Its normal rating is 2200 H. P., but while accelerating it will easily develop the enormous amount of 4,000 H. P.

"No piece of mechanism in the world could be taken as a better illustration of the progress made in electrical science towards solving the problem of main line electric traction. It both design and construction it is radically different from any other locomotive yet built."

The control is of the Sprague-General Electric multiple unit type, permitting two or more locomotives being coupled together and

operated from the cab of either one in the same manner as a single locomotive and with the power of the two combined.

"For the purpose of testing these locomotives under actual service conditions, the New York Central Railroad set aside a stretch of track on one of their main lines west of Schenectady. This was equipped with a third rail for a distance of approximately six miles. A 2,000 KW Curtis Turbine in the General Electric Power House at Schenectady provides the necessary power.

"Numerous tests of a most severe and searching nature have been made. Locomotive No. 6000 was first taken out on the experimental track on October 26, 1904, and between that date and the present time it has run over 50,000 miles. This locomotive has been run in all sorts of weather, including driving storms, heavy snow storms, blizzards, high winds and excessive heat.

"On one occasion a continuous run of 18 hours was made in a driving snow storm with the locomotive hauling a 335-ton train. A schedule speed was maintained that would give results comparable with those required in actual service.

"Trains up to eleven cars have been hauled during the trial run, and with the lighter train a speed of 85 miles per hour has been attained.

"Among the interesting and exciting features during the trials was a series of competitive runs with a steam locomotive having the same weight on drivers and hauling the same weight of train. In each case the electric locomotive beat its competitor, and the engineman of the steam locomotive, who at the start was confident of pulling off a victory for his engine, came to the conclusion that he might win a race if he could change places with the motorman in the cab of the electric locomotive. The results of all trials, to which the locomotive has been subjected, have proven it a great sucess from every standpoint.

"The record of maintenance for the entire period has been carefully kept and shows a cost of maintenance for the electric locomotive of less than two cents per locomotive mile as compared with the cost of from five to seven cents per locomotive mile for steam locomotives in similar service.

"The following will give the principal electric data and mechanical details in tabular form:

Normal rated capacity	2,200 H. P.
Number of motors	4
Type	G. E. 84-A
Normal capacity of each motor	550 H. P.
Supply voltage	660 volts
Normal full load current	3,050 amp.
Speed with 500-ton train	60 M. P. H.
Maximum tractive effort	40,000 lbs.

Number of driving wheels	8
Diameter of driving wheels	44 in.
Diameter of driving axles	8.5 in.
Number of truck wheels	4
Diameter of truck wheels	36 in.
Wheel base, driving	13 ft.
Wheel base, total	27 ft.
Total weight	97 tons
Weight on drivers	68 tons
Length over buffer platforms	37 ft.
Extreme width	10 ft.
Height to top of cab	14 ft. 4 in."

SLIDES.

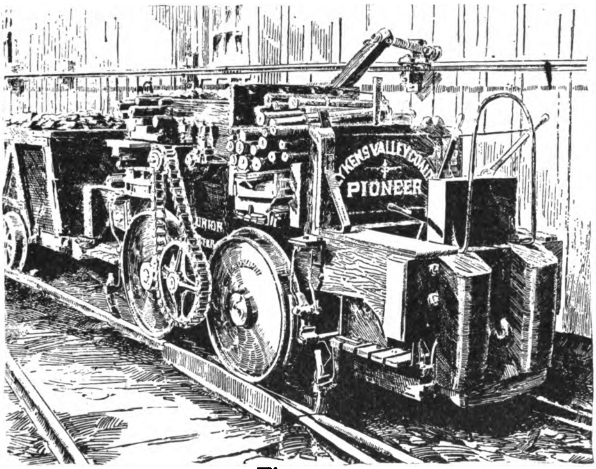


Fig. 41.

Fig. 41. This locomotive was one of the old pioneers.

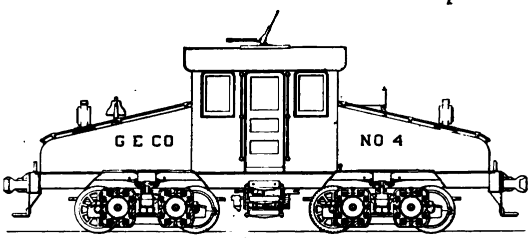


Fig. 42.

Fig. 42. This is one of four locomotives now in use in the Schenectady yards of the General Electric Co. Here you will see the arrangement of the motors connecting with each of the trucks.

Fig. 43.

Fig. 43. This is the same locomotive, complete as it operates.

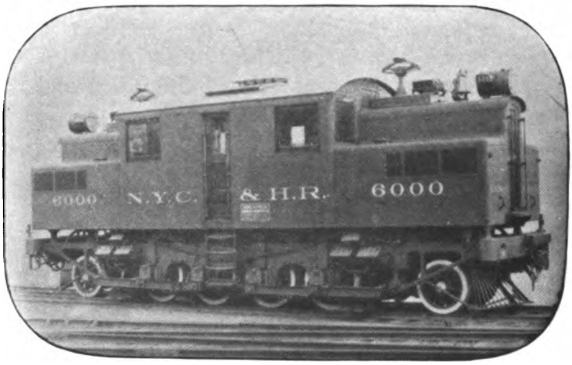


Fig. 44.

Fig. 44. This is the New York Central locomotive.

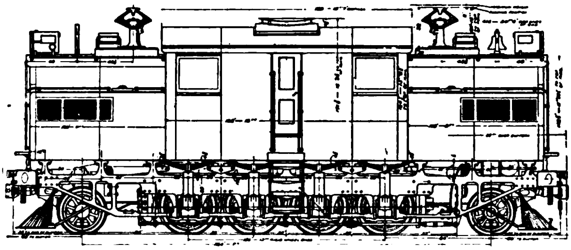


Fig. 45.

Fig. 45. This shows the arrangement of steel construction of this locomotive.

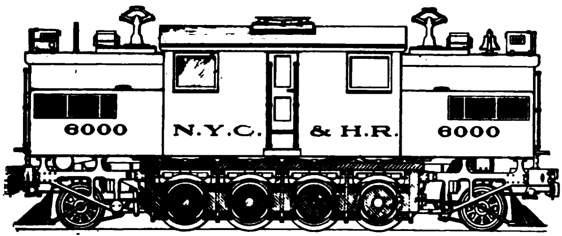


Fig. 46.

Fig. 46. Here is rather an interesting section showing you the armatures. You have seen the armatures mounted on the axles of the locomotive. Here are the fields and part of the steel framework which supports the body of the locomotive. The field coils you see in sections for magnetizing the field poles, and the magnetic flux flows right straight through from one end to the other. The mechanical arrangement is such that the armature can easily be cut out, permitting other motors to continue in service. The trucks and frames can be dismantled very easily and quickly.

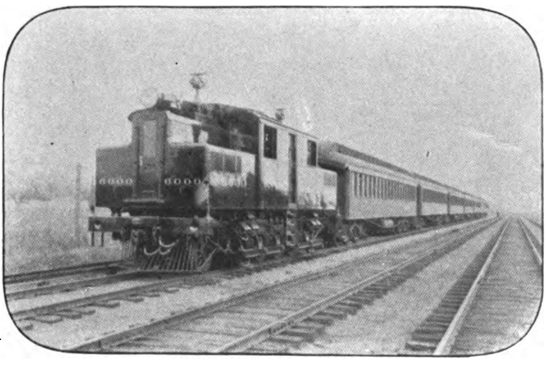


Fig. 47.

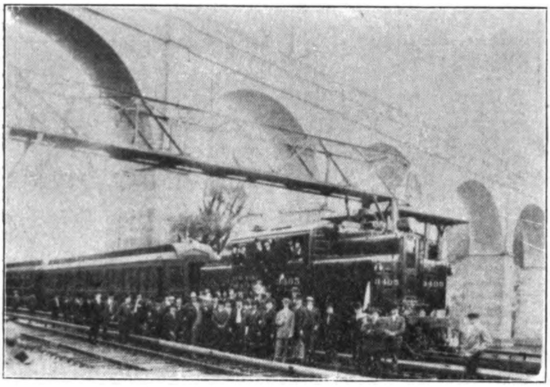


Fig. 48.

Figs. 47 and 48 are views of a New York Central train. Fig. 48 is the first train pulled over the road.

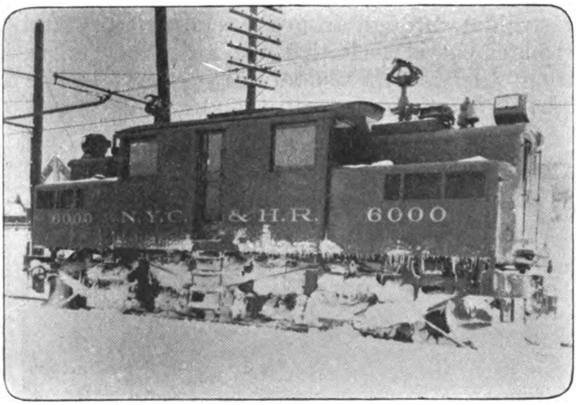


Fig. 49.

Fig. 49. Here is one of the locomotives after it has had some experience in a snowstorm.

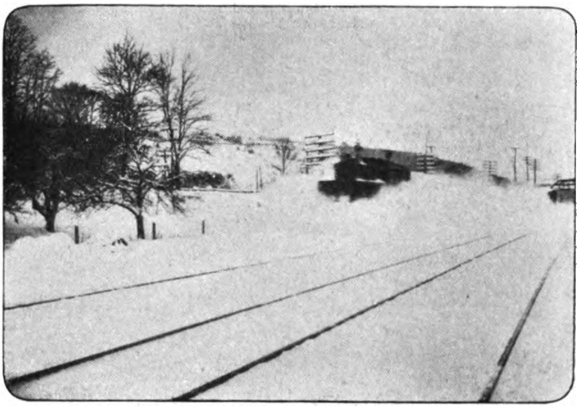


Fig. 50.

Fig. 50. Here is one out in a snowstorm.

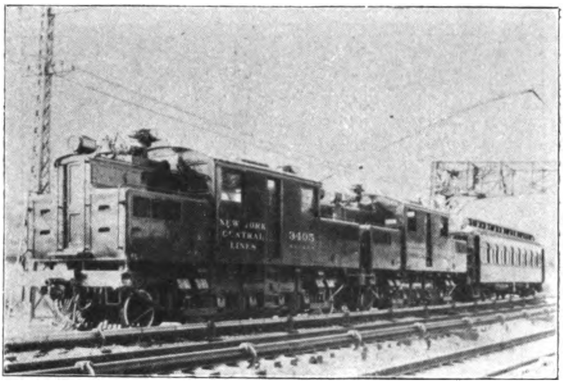


Fig. 51.

Fig. 51. There are two of these locomotives and this shows a stretch of the third rail.

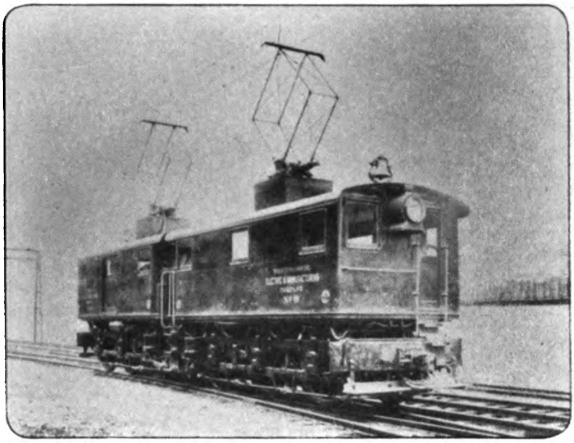


Fig. 52.

Fig. 52. Is a 125-ton A. C. locomotive that was built by the Westinghouse Company for the Grand Trunk Railroad tunnel.

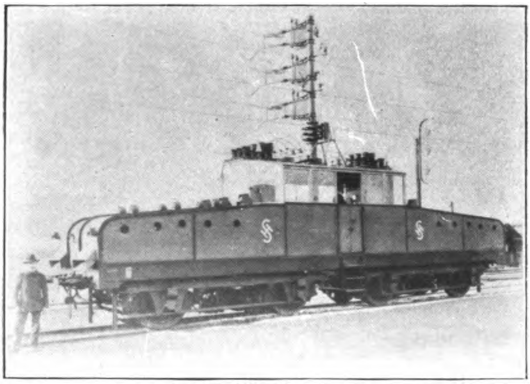


Fig. 53.

Fig. 53. This is a locomotive that was built for 10,000 volt A. C. work by The Siemens & Halske Co.

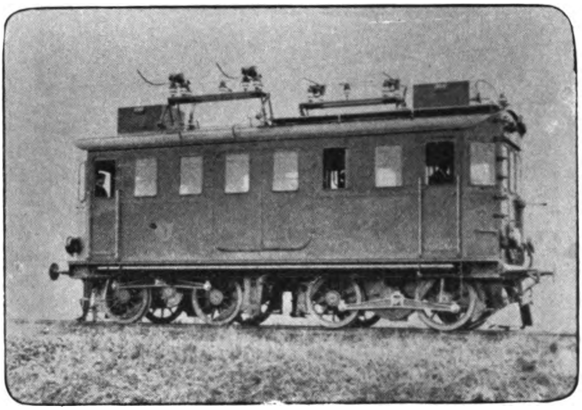


Fig. 54.

Fig. 54. Is another type of high tension locomotive built by the Oerlikon Co. This was made for 6,000 volts, equipped with single-phase motors, 400 H. P., weight of locomotive 47 tons.

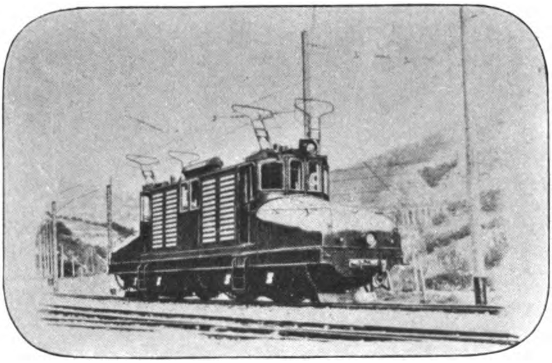


Fig. 55.

Fig. 55 is a type of French locomotive, 50 tons, 500 H. P., 2400 volt D. C.

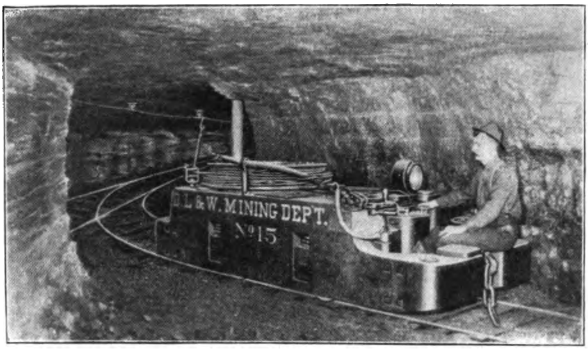


Fig. 56.

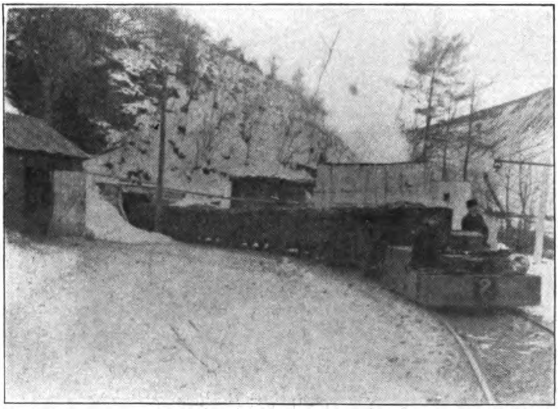


Fig. 56½.

Figs. 56 and 56½ show types of mining locomotives, many of which are in use.

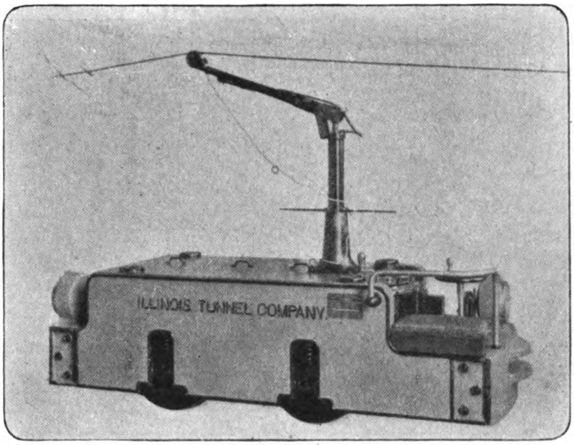


Fig. 57.

Fig. 57 shows another view of locomotives of which there are quite a number under our streets in Chicago.

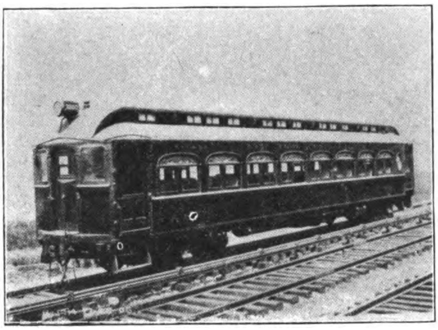


Fig. 58.

Fig. 58. Is one of the new steel cars used by the New York Central, which may be of interest. These cars are equipped, as I stated before, with two 200 H. P. motors.

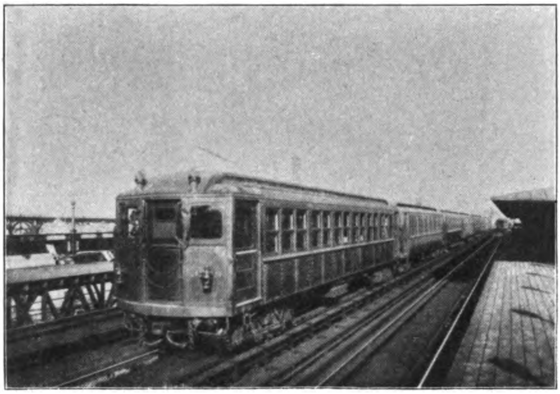


Fig. 59.

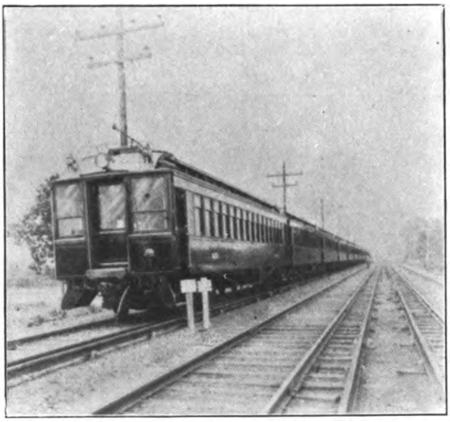


Fig. 60.

Figs. 59 and 60 show a train of N. Y. Central steel interurban cars. The cut also shows the third rail.

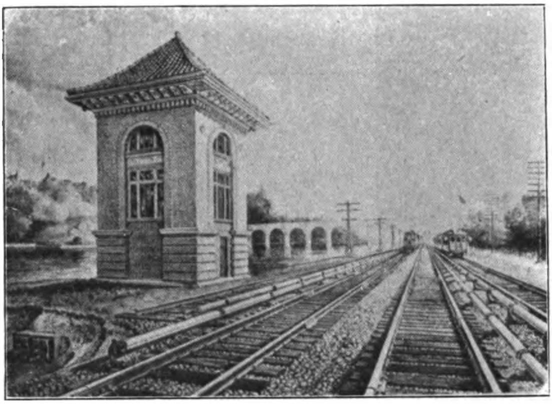


Fig. 61.

Fig. 61. This shows the general electrification of the road, the high tension pole line with the iron mast and the track construction. This third rail is entirely protected. This also shows the protected third rail construction. Here is the overhead line bringing power to this point where it goes down underground in cables into the city.

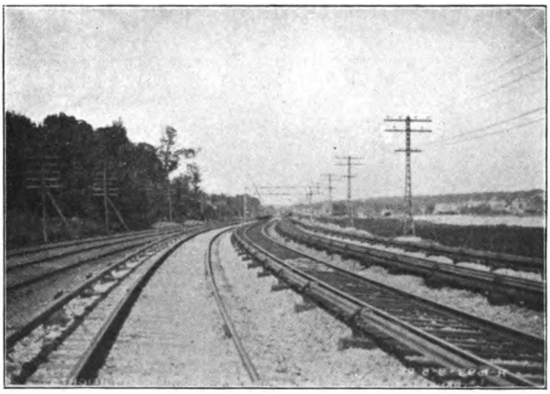


Fig. 62.

Fig. 62 shows general track view with a signal bridge in the distance.

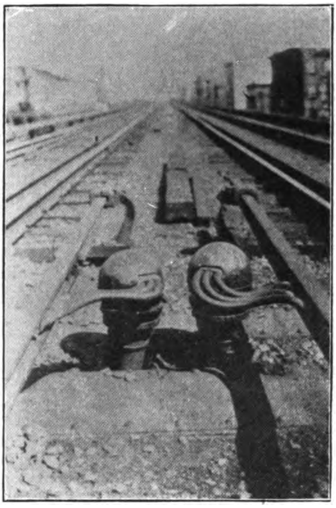


Fig. 63.

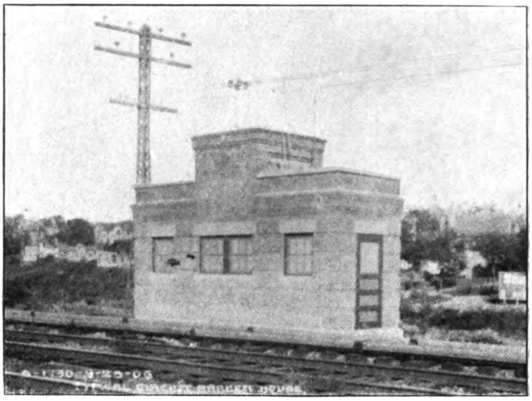


Fig. 64.

Fig. 63. Here is where the current is carried from underground cables and connected onto the third rail.

Fig. 64. Here is one of the stations which is built to contain circuit breakers which are operated from the automatic switches operated from the train despatcher's office, which can automatically cut the current off from any section. In that way, if a mistake should be made by the train despatcher he could probably avoid a collision by cutting out the circuit.

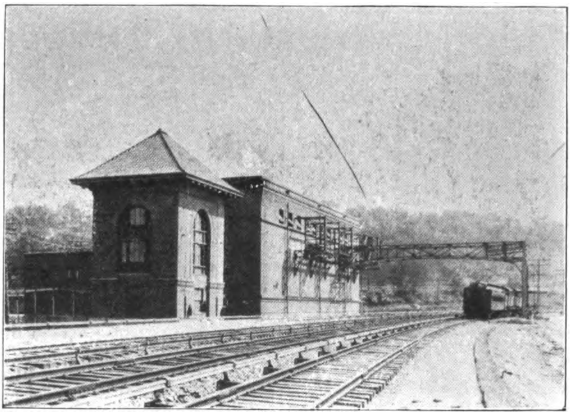


Fig. 65.

Fig. 65. This is a sub-station, and here (Fig. 66) is the interior of the sub-station, the rotary converters and various auxiliary apparatus.

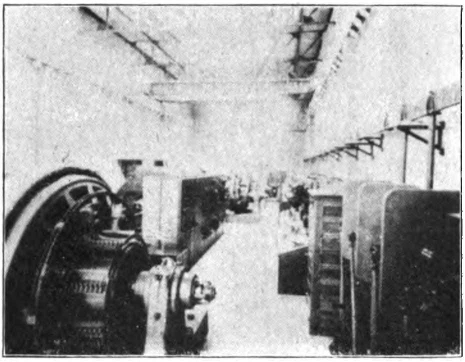


Fig. 66.

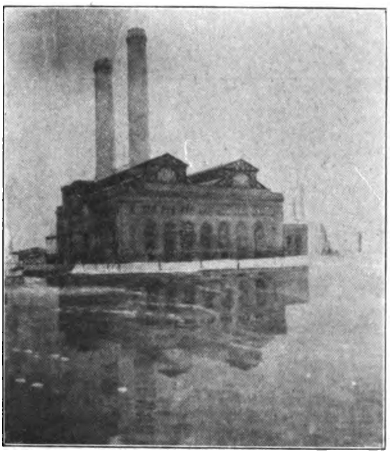


Fig. 67.

Figs. 67 and 68. Here is one of the power houses and the interior of the steam turbine room, showing four vertical 7,500 H. P. Curtis steam turbines.

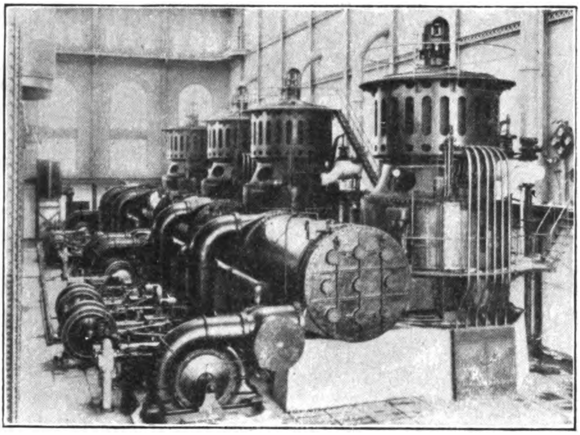


Fig. 68.

Fig. 69.

Fig. 69. This view shows the third rail construction in the city of New York; the high tension cables are carried in these pipes.

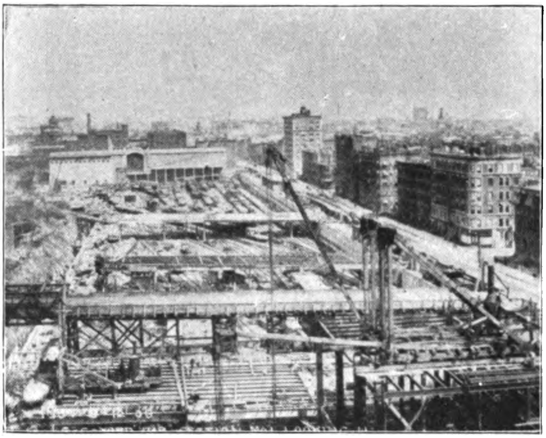


Fig. 70.

Fig. 70. This shows the work that is now going on in reconstructing the yards at Forty-second street and Grand Central Station.

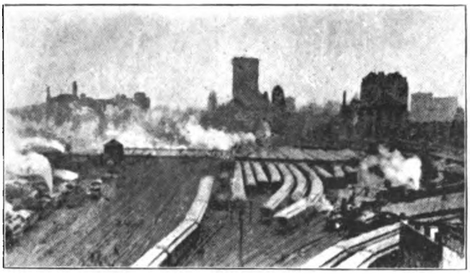


Fig. 71.

Fig. 71. This view is the same, operated as they were by steam.

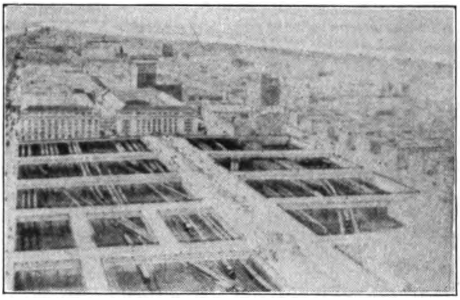


Fig. 72.

Fig. 72. Shows the yards as they will be when completed. They will all be down below the level of the streets. In the distance is the Grand Central station as it will appear when rebuilt.

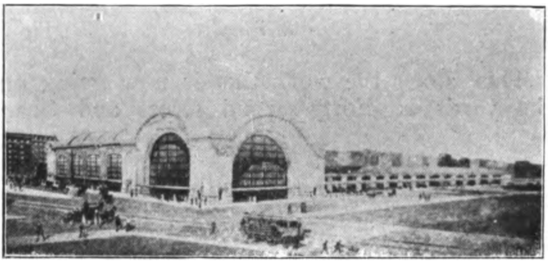


Fig. 73.

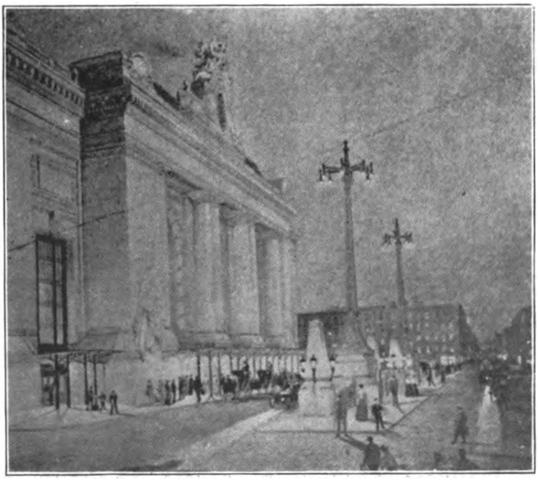
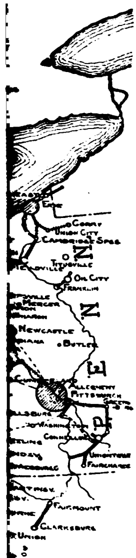


Fig. 74.


Erie
Corry
Union City
Cambridge Sprs.
Titusville
Oil City
Franklin
Mercer
Newcastle
Butler
Allegheny
Pittsburgh
Uniontown
Fairchance
Fairmount
Clarksburg

LWAYS

Figs. 73 and 74 show the general appearance of the Grand Central station when rebuilt.

This is a map that is very interesting that Mr. Arnold recently made, showing the tremendous growth of the interurban business through the middle West. You see this perfect network of interurban electric roads all through this Lake region.

Mr. President, I regret that I have occupied so much time. I am very much obliged to you all for your attention. (Applause.)

THE CHAIRMAN: I am sure we are all very greatly indebted to Mr. Lyman for this talk and the slides. We still have some time left for discussion and we do not wish to confine it to our own membership, although we have some electric people in our membership. There are, I believe, a number of invited guests in the room and any one who desires to speak in the discussion will be given the opportunity to do so. Is Mr. Stearns in the room?

MR. R. B. STEARNS (G. M. Chicago & Milwaukee Electric Ry.): I do not believe I have anything particular to add to Mr. Lyman's remarks. He has presented the electrical situation very admirably and very interestingly indeed. I did not come prepared tonight to make any remarks at all.

MR. CLEMENT F. STREET (Commercial Engineer, Westinghouse Electric & Manufacturing Company): Mr. Chairman and Gentlemen: I have been very much interested in the paper presented this evening and in view of the interest in the subject now being manifested by the officials of steam railroads, consider it very apropos. There is very little I can say in direct discussion of the paper, but as I have been sitting here the thought has entered my mind that the engineering problems now being presented to steam railroad men are much more complex and of greater magnitude than at any time in the history of the science. There has never before been any engineering problem of as great importance as that of the proper application of electricity to handling of heavy railroad traffic, and the manner in which this problem is being solved in remarkable. It is hardly possible for any one who has not spent considerable time at the large railroad terminals in New York City to have any adequate conception of the magnitude of the work which is being done at that point. The application of electricity to the New York terminal of the New York Central Lines is an undertaking of tremendous proportions, and the successful carrying out of this project necessitates the solution of problems which are entirely new to engineers.

The new terminal of the Pennsylvania Railroad in New York City also involves the solution of tremendous engineering problems, but these are altogether of a different nature from those encountered in the New York Central Terminal.

The projects of the Hudson companies and the Interboro present

still another class of engineering problems, almost if not fully equal in immensity.

The tremendous network of tunnels, heavy electric railroads and projects of this nature now in the course of construction about New York City is something the like of which the world has never before seen, and all of it is made possible only by the use of electricity.

The progress made during the past two or three years in the solution of the problem of handling heavy railroad traffic by electricity is undoubtedly greater than all that made in the entire previous history of the use of electricity in railroad work. Up to about three years ago the limitations of electric apparatus were such that it was confined exclusively to street, elevated and interurban railways, and electricity was being used to do things which a steam locomotive could not do. Within the past few years, however, there has been a radical change and the new systems of electric traction now in use will not only do the same things the old ones would, but in addition will do any of the things which a steam locomotive will do, and do some of them at a lower cost.

Steam railroad engineers in considering the replacement of the steam locomotive by electricity are confronted with engineering problems of greater magnitude than ever heretofore presented. First, there is the question of power house. A few years ago the main question to be decided in the construction of a power house was which of the many types of steam engines and boilers would be used. At the present time, the first question to be decided is whether a steam engine will be used at all. If not, whether it is advisable to use a steam turbine or a gas engine; and after these main points have been decided, the question comes up of the relative advantages of the different makes of the different types of apparatus. The development of the steam turbine and the gas engine has of recent years been fully as rapid as that of the use of electricity.

The next question to be decided is whether an A. C. or D. C. system should be installed, and the proper solution of this problem presents many knotty questions.

I am further of the opinion that the steam railroad men have a wrong impression of the views of electric engineers regarding the displacement of the steam locomotive. There seems to be a general feeling that electric engineers are of the opinion that the steam locomotive will disappear within a very few years. This is entirely unwarranted by any statements which have been made by any electric engineers who are capable of discussing the subject. The use of electricity for handling heavy railroad traffic is coming just as fast as electric engineers and manufacturers of electric apparatus can take care of it. The problems being presented are new, require a great deal of study and their solution necessarily requires the expenditure of a large amount of time and money. I think that

an altogether unwarranted and unintended inference has been drawn from the paper recently presented at the Institute of Electric Engineers by Messrs. Stillwell and Putnam. In this paper a tremendous mass of figures is given showing what in the opinion of the writers would be the result if all of the railroads throughout the country now being operated by steam locomotives, were operated by electricity, but the facts have been overlooked that the authors of this paper are very careful to say that the immediate and general adoption of the new motive power by our railroad companies is neither possible nor desirable.

It is very easy to make general statements on this great subject, but it is impossible to draw any general conclusions which are of much value. The important feature of the situation to steam railroad men is the fact that the introduction of the new systems of electricity has placed at their disposal an entirely new agent for use in the problems which are continually being presented to them. The proper use of this agent is a question of vital importance and the only way in which great benefit can be derived from its use is by making a careful and exhaustive study of the things which can be accomplished by its use.

THE CHAIRMAN: Professor Woodworth of Lewis Institute was specially invited to be present and we hope we can hear something from him.

PROF. WOODWORTH (Lewis Institute): I would say that I feel a little bit small in facing this problem. I know that the problem of the electrification of steam railroads is the largest thing that the engineers of the world have tackled. The optimistic views taken by Mr. Lyman, the grand success especially indicated on the New York Central, do not indicate to me and I do not think indicates to any one what is coming at all. The idea would be, as I understood Mr. Lyman tonight, that in probably a very short time we will have electrical railroads everywhere and steam railroads will be a thing of the past. I happen to know a case recently where a steam railroad was in the hands of operators and they concluded that the proper thing was to electrify the road. They went to the manufacturers for that purpose and said, "We want to electrify our steam railroad," and the question the company asked them was this, "How many trains do you operate a day?" They told them and they said, "You just go right home and run your steam engines." They will be running steam engines for a great many years to come on that road. That was the statement made by the electrical firm. In other words, this question is one of capacity more than any other one thing. Where a steam railroad has reached its capacity, then they are usually ready to electrify. In addition to the statement made here tonight, I think I know of one other remarkable case; I believe the Erie railroad has practically closed a contract to

electrify two hundred miles of their track running into New York City, indicating another one of the great big problems.

MR. C. V. WESTON (C. E. South Side Elevated Ry.): I came here to listen, not to speak. It seems to me that the problem of electrifying steam railroads is one that will be confined for a great many years to the electrification of terminals in large cities. As the gentleman who has preceded me stated, it is a question of capacity. The difficulty of handling a very large traffic in a small area becomes one which resolves itself into a problem of moving trains quickly into and out of that area. Therefore, it seems to me that the special problems of the electrification of steam railroads to-day would be to provide suitable terminal facilities in large cities.

MR. STREET: I should like to correct the statement about the Erie Railroad. The daily newspapers published a statement that they have let the contract for the electrification of their suburban lines. I know that is not true. They figured on it and expect to do it just as soon as the money conditions are in shape; also the D., L. & W. R. R., and some of the largest railways of the country, but nothing definite has been done.

PROF. WOODWORTH: I will accept the correction.

MR. J. C. OSMER (Northwestern Elevated R. R.): It is reasonable to believe that if a reciprocating engine is to remain in use, the proper place to put it is in the power house. The steam locomotive boiler mounted upon frames is subjected to conditions that in some cases causes it to be inadequate, due to the destroying of the vacuum on account of leaky steam pipe or exhaust nozzles, stand joints, and numerous other causes that the boiler in itself is not responsible for, but on account of the conditions it is subjected to, which is eliminated at the power house where the boiler is separated from the steam engine, where a cheaper grade of coal can be used, and by means of natural draft facilities a horse power can be furnished at a much less figure than can be produced with the steam locomotive. Furthermore, one man in a power house can carefully inspect the machinery of a number of units, whereas with the steam locomotive two men are in care, but not in a position to observe defects of the reciprocating parts.

MR. M. K. BARNUM (C., B. & Q.): The question of engine failures which was the subject of our last monthly meeting, is ever present with the man who has to do with steam locomotives. There are approximately possible two hundred different causes of engine failures, and from what we hear about electric locomotives it seems that a large percentage of them would be eliminated. We would like to hear from the men who are familiar with electric locomotives—what new kinds of failures they are liable to, and which of those incident to steam locomotives they will eliminate.

Another most promising advantage of the electric locomotive is its adaptability to heavy grades in the mountains where electricity

can be generated by water power. Throughout the mountainous country the railroads generally follow the water courses, and it seems possible there to utilize the electric locomotive more profitably and more efficiently than the steam locomotive. I understand that this subject has been canvassed by one or two of the railroads crossing the Rocky Mountains and the advisability of electrifying their heavy grades depends upon how much business they have to handle. When the amount of business reaches a sufficient volume (which depends upon local conditions) it will pay to use electric power for handling both freight and passenger trains over the heavy grades.

Mr. W. G. Wallace: I have listened to this paper and discussion with a great deal of interest. There is one important matter in regard to the operation of an electric locomotive that has not been touched upon this evening, something that railroad men will have to handle when they electrify the roads, and that is, the crew for the electric locomotive. Years ago railroad men figured that you had to have some gray hairs in your head in order to pull passenger trains. I presume there are a number of men in the room who have run locomotives with small wheels after they had sufficient experience to qualify them for passenger service. By a change of power they would get an engine with large wheels, he would be ahead of time, or if he worked steam up to the usual shutting off place, he would be going faster than he did with the small wheel; sometimes he would run to the station for a trip or two until he became accustomed to the speed in that class of locomotive. It is a difficult matter to educate competent locomotive engineers for the service that we have to-day. If a man were asked to go out and employ fifty good locomotive engineers, I don't know where he would get them, and they have had all these years to qualify for that service. If we are going to use electric equipment, the man has not got exhausts to tell him how fast he is going; he does not get the rocking of the engine, but the motor takes him along until he is going faster than he really thinks he is. It seems to me we ought to have a man on that electric locomotive who would be experienced and have the judgment that would enable him to handle his trains with pretty nearly the same care, with the same feeling of the track and speed of the train that the old locomotive engineer has. I would like to know if the men who are handling electric equipment to-day are finding any difficulty in getting proper men to take charge of the electric locomotive.

The Chairman: I do not think there is any one present competent to answer the question. The elevated men here in Chicago carry us around the curves at a pretty lively rate sometimes. Probably that is not the fault of the office men. Any further discussion?

Mr. W. E. Symons: It seems that history repeats itself in this matter of electricity as it has in many other things. In the early history of the steam locomotive there were many unsolved questions

that required much time, experiment, expense and the loss of many lives in the effort to analyze certain difficulties, and arrive at proper remedies therefor: The application of electricity as a motive power for railways presents the same, if not greater difficulties, which are being met and overcome in pretty much the same manner.

It is not many years ago, probably about twelve or fifteen, that a distinguished American citizen, and a prominent railway magnate, predicted that in ten years' time the steam locomotive would probably be a thing of the past, yet after twelve or fifteen years' time has elapsed, we find that the locomotive works have about doubled, and in some instances trebled their capacity and output, and are to-day spending as much, if not more, money on improved equipment of a permanent character for the manufacture of steam locomotives than the electric people are in trying to meet requirements in filling orders for their devices.

This special equipment installed by the steam locomotive manufacturers, and also by railway companies, for the manufacture and maintenance of steam locomotives is of such a character as to preclude the possibility of its purchase and installation being considered for temporary use; in fact, the special equipment for the manufacture of, and the character of the steam locomotives produced, are such as to insure its being a prominent factor in railway transportation for many years to come; therefore, the question resolves itself into this; that electricity as a means of transportation, while it is a modern improvement or an advance in modern methods of transportation, belonging as it does among the higher branches of engineering, will, undoubtedly, travel, or progress along with the steam locomotive, which will be much in evidence until after we have all left this earth, and some of our children's children, although the steam locomotive will, undoubtedly, yield its place to electricity in all our larger cities and other places where electricity is more desirable, or necessary, to meet certain conditions; in other words, as has been mentioned here this evening, the present field for electricity is confined to certain localities, or conditions.

I was not a little surprised at my friend, Mr. Manchester, not offering, in response to the invitation to speak, some valuable information in connection with the question of "Steam vs. Electric Locomotives." This, from the fact, that he is at the head of the motive power department of one of the leading railways of the country, with headquarters located in a district where electric lines are becoming quite prominent, with indications that it is making much inroads on the railway company's revenue, yet at the same time, he is not only buying locomotives, but has in operation one of the largest, if not the largest, locomotive works owned and operated by a railway company in America, and, doubtless, he is in as good, or better position, than any one else to intelligently dis-

cuss the relative merits of the two kinds of motive power. The subject has, undoubtedly, been thoroughly analyzed by him, as evidenced by the fact already mentioned, that he is building a great number of first-class steam locomotives, that will be good serviceable engines fifteen years hence.

While the use of electricity, and also of steam, is simply an adaptation of the forces of nature to the uses of man, and are, therefore, both of them essentially engineering questions, yet, the application of electricity on an original line, or its substitution for the steam locomotive, is, at the present time, questions that must be worked out in each particular case, selecting the one most suitable to fit the locality and conditions in general.

The question of the use of electricity in place of steam also brings up a feature of operation mentioned by the last speaker, and on which I would be very glad if the author of the very valuable and interesting paper to which we have listened this evening would touch upon in his closing remarks, particularly in connection with the matter of speed, ability to control and dangers resulting therefrom as compared to steam propelled trains.

I think it was only a few days ago, possibly last Saturday night, that on one of the leading railroads of America, recently equipped with electricity, there occurred a very bad accident, in which a number of lives were lost, and while it is claimed for electricity, that there is freedom from fires; if the newspaper accounts are correct, some of the passengers in this ill-fated train were burned.

If any data, or information, as to the cause of the accident, which so far seems to be unknown, can be furnished, I am quite sure it would be interesting to all.

Mr. A. E. Manchester (C., M. & St. P. Ry.): It will not take me very long to tell you what I know about electrifying steam railroads, and one of the reasons why I did not respond when our president called upon me was that I was feeling and thinking very much like a conductor who once had a wreck under circumstances in which it was quite plain and evident to him that he was going to get into trouble, and it happened to be my misfortune to have to help to pick up the wreck. In doing so I asked him to give us some assistance in the matter of holding lights and moving his engine around this place and that; I heard him make this remark, "It's Hell when a man has to be pallbearer at his own funeral." (Laughter.)

The Chairman: I hope some of the railroad men who are not as pessimistic as Mr. Manchester will cheer him up.

Mr. W. C. Squire: I think Mr. Manchester is wearing the crape too soon.

Mr. W. O. Moody (Mech. Engr. Ill. Central R. R.), Communicated: Mr. Lyman's paper has been very instructive and gives the

steam locomotive men an insight into the interior construction of apparatus, which will figure on failure report sheets of the future, in place of valve gears, boilers, etc.

It would appear that writers, in drawing comparisons between the steam and the electric locomotive, as to cost of maintenance and efficiency in operation, do not bring out sufficiently clear the details as to the steam end of the proposition, to determine the type of engine with which comparison has been made. It occasionally is brought to notice, however, that the electric machine, of most recent construction and highly developed type for special conditions, is ranged beside a steam locomotive of average power and not the latest up-to-date machine. While passenger trains of 400 tons, at 35 miles per hour, would represent an average, a modern Pacific type will handle 600 tons at 60 miles per hour. In comparison of maintenance costs, the fact should be born in mind, that workmanship, design and material in both cases should have relatively similar values for accurate and reliable results.

The ideas that danger of fire is eliminated by the introduction of electricity is hardly substantiated by facts brought out by a recent derailment of a passenger train having a third rail conductor. A wreck of any magnitude, freight in particular, will be likely to disturb the third rail, and in case of derailment at speed, the trolley poles would be in danger.

With the steam locomotive, a washout disturbs the right of way only, not interfering with the sources of power, which latter can negotiate several feet of water over the rails, without interfering with the fires on the grates.

The steam locomotive has not reached the limit of development, and many such devices, which procure for the power house a comparative economy of output, are being tested out on the locomotive, with the idea of suiting them to its peculiar conditions.

The latest development of the electric locomotive for high speed service, has a two wheel truck at either end for guiding purposes, which may prove ample for machines with a low center of gravity, but the future may bring out the necessity for the four wheel variety, which has proven its worth on steam operated roads, where conditions demand a maximum of speed.

THE CHAIRMAN: If there is nothing further, I will ask Mr. Lyman to close the discussion.

MR. LYMAN: Professor Woodworth has inferred a more optimistic view than is actually given in this paper.

I stated:—"The electric railway motor has reached a point of development where it can advantageously replace the steam locomotive for much suburban service and in certain instances for through passenger and freight service where traffic conditions are especially congested."

I agree with the Professor that the time is not ripe for the general electrification of steam railroads.

Referring to the reliability of service of the electric locomotives and electrically operated trains,—in Mr. Stillwell's recent paper which has been referred to this evening, he gave a splendid instance of comparative reliability of service from experience of the Manhattan Elevated since they have changed over from steam to electric drive, covering a considerable period of operation. They found that the train mile delays of any kind whatsoever, either from defective apparatus or failures in operation, the time lost in the movement of electric trains was less than half the time lost in the movement of trains operated by the steam locomotives, and it covered a period during the winter season when, as we all know, there is more or less trouble from ice and snow and sleet on the unprotected third rails. In New York the third rails on the elevated are all unprotected and although some of the delays were due to the electrical equipment proper it has shown a perfectly wonderful record in time lost due to defects or trouble of any kind as compared with steam locomotives, being much less than one half the time lost by steam locomotives on the same service.

Referring to the education of engineers for electric locomotives, this question has been solved by the New York Central, as I think it will have to be by all railroads, by putting out the electric locomotive a year or two in advance of regular service and giving their locomotive engineers an opportunity to become familiar with the electrical control. The steam locomotive engineers are familiar with all the train movements and the road and right of way, etc., and signaling. With this experience they have become thoroughly reliable electrical engineers. The N. Y. C. R. R. now have a well trained crew of electrical locomotive engineers who are certainly competent to handle the work. Referring to the control of electric locomotives a Boyer speed recorder and a few electric instruments will show very accurately and exactly the speed the locomotive is running.

The speed control is perfect. An acceleration of a mile and a half per hour per second can be easily made, which is about double the speed acceleration of a good steam locomotive, and two miles per hour per second can be obtained in breaking. The electric locomotive is controlled by the little master controller, shown above, which is about one quarter the size of a controller in ordinary street car use. This controller allows the power to be turned on and off governing the speed of the locomotive to a nicety. Those who are familiar with motor operated machinery know how closely you can adjust the speed of it. Take a printing press or any other kind of machine. The machine shops of the Rock Island road at Davenport are equipped with individual electric drive; the chairman just told me

how perfectly they operated, how much more work some of the machines can accomplish by means of the perfect control that the operator has in getting any speed that he wants out of his machine. The same thing is true of an electric locomotive. There is nothing in the world that can be so perfectly controlled as an electric locomotive, or an electric train. In the service on elevated roads, if a motorman is negligent and allows his train to run around a curve at full speed, why, it has not anything to do with the electrical apparatus itself; that is a personal factor entirely.

MR. SYMONS: Mr. President, before any members leave the room, I would like to propose a vote of thanks in favor of Mr. Lyman for this very valuable paper he has read here this evening, and the explanations given.

Motion carried unanimously.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Annex on Tuesday evening, March 19, 1907, President H. T. Bentley in the chair. The meeting was called to order by the President at 8 P. M.

Among those present the following registered:

Ames, C. F.
Adams, C. E.
Allison, W. L.
Ayers, A. R.
Baker, F. L.
Ball, R. L.
Barnes, C. A.
Barnum, M. K.
Beatty, W. H. Jr.
Bentley, H. T.
Bentley, W. F.
Bott, A. G.
Bowers, K. J.
Brown, B. E.
Brown, C. L.
Bryant, G. H.
Callahan, J. P.
Carlton, L. M.
Carroll, H. C.
Cardwell, J. R.
Cram, T. B.
Davidson, G. M.
De Voy, J. F.
Dodd, T. L.
Doud, Willard
Dow, G. N.
Estrup, H. H.
Fantom, Wm.
Farmer, G. W.
Fenn, F. D.
Fitzmorris, Jas.
Flavin, J. F.
Fogg, J. W.
Forsyth, Wm.
Gardner, H. W.
Garrett, M. A.
Gilmore, F. M.
Goodnow, T. H.
Gowing, J. P.
Haas, G. H.
Haig, M. H.
Henderson, T. D.
Hill, C. P.
Hincher, W. W.
Hinds, J. B. L.
Hubbell, I. C.
Hyland, C.
Jeffries, B. H.
Jenks, C. D.
Johnson, W. W.
Kadish, R. B.
Keeler, Sanford
Kelley, H. D.
Kelly, J. W.
King, C. H.
Lancaster, J. R.
LaQuay, M.
LaRue, H.
Lawson, W. C.
Lewis, J. H.
Lickey, F. G.
Little, J. C.
Maher, P.
McAlpine, A. R.
McCarthy, M. J.
McGee, J. G.
Macpherson, A. F.
Manchester, A. E.
Medland, W. C.
Meeder, W. H.
Midgley, S. W.
Miller, F. W.
Monroe, M. S.
Moody, W. O.
Moskowitz, M.
Munger, E. T.
Ott, O. W.
Otto, Oscar
Parker, P.
Parsons, Chas.
Phillips, L. R.
Phipps, D. L.
Robinson, J. G.
Rower, Harry
Schmidt, E. C.
Seley, C. A.
Sharp, W. E.
Shults, Chas.
Slaughter, H. W.
Smith, Robt.

State, R. E.	Taylor, J. W., Jr.	Walbank, R. T.
Stimson, O. M.	Thomas, C. W.	Webb, E. R.
Stott, A. J.	Thompson, E. B.	Whalen, J. M.
Sullivan, C. L.	Thompson, J. R.	White, W.
Symons, W. E.	Thurnauer, Gustav	Wickhorst, M. H.
Talbott, Chas.	Tinker, J. H.	Wolfe, F. E.
Taylor, E. D.	True, C. H.	Woods, E. S.
Taylor, J. W.	Vincent, M. M.	

THE PRESIDENT: The meeting will please come to order.

The first business of the meeting will be the approval of the minutes of the last meeting as printed and distributed. Unless there are any objections they will stand approved.

We will now have the report of the Secretary.

THE SECRETARY: Mr. President, I have the membership report, as usual.

Membership February, 1907		1,365
Resigned	11	
Dead	1	12
		1,353
New members approved by Board of Directors		12
		1,365

NEW MEMBERS.

K. J. Bowers, Mgr. of Sales, Acme White Lead & Color Works, Detroit, Mich	J. W. Taylor
J. J. Conolly, S. M. P., D. S. S. & A. Ry., Marquette, Mich.	J. W. Taylor
E. E. Kretschmer, Northwestern Elevated R. R., Chicago	J. E. Osmer
Jas. G. Wishard, C., R. I. & P. Ry., Chicago	A. K. Shurtleff
A. J. Walsh, Loco. Engr., Mo. Southern Ry., Leeper, Mo.	C. A. Swan, Jr.
W. M. Drennan, Osterman Mfg. Co., Chicago	R. B. Kadish
H. C. Osterman, G. M., Osterman Mfg. Co., Chicago	R. B. Kadish
Benson E. Brown, J. B. Sipe & Son, Detroit, Mich	J. W. Taylor
F. D. Shumate, H. R. Worthington, Chicago	H. T. Bentley
A. L. Hatzman, Rubberset Brush Co., Chicago.	R. B. Brydon
R. E. Gurley, C. E., The Otis Gas Eng. Wks., Chicago	G. M. Davidson
J. H. Bendexen, Bettendorf Axle Co., Davenport, Ia	A. F. Macpherson

RESIGNED.

M. McKeen.	J. B. Patterson.	C. M. Taylor.
F. D. Johnson.	A. F. McIntyre.	E. S. Taylor.
G. F. Slaughter.	J. J. Merrill.	G. L. Nelson.
A. B. Grossman.	O. W. Buenting	

DEAD.

G. W. P. Atkinson.

THE SECRETARY: Mr. President, I would like to say at this time that at our April meeting it is possible we may have Mr. W. A. Gardiner, Vice-President of the Chicago & Northwestern Railway, give us an address. He is a pretty busy man, as you probably know, and in case he is not able to be with us, we will have a paper on Elec-

tric Lighting of Passenger Cars by Mr. O. W. Ott of the mechanical department of the Burlington. In addition to that, we should have the report of the committee on revision of the Rules of Interchange,

THE PRESIDENT: The paper assigned for this evening's talk is "The Heat Transmission Loss Due to Boiler Scale and Its Relation to Scale Thickness." We have with us tonight Mr. E. C. Schmidt, Associate Professor of Railway Engineering, University of Illinois, who has prepared this paper and will read it. I have pleasure in introducing Prof. Schmidt.

E. C. SCHMIDT (University of Illinois):

Mr. President and Gentlemen:—The subject of the paper has been announced as:

THE HEAT TRANSMISSION LOSS DUE TO BOILER SCALE AND ITS RELATION TO SCALE THICKNESS.

The following paper is a summary of Bulletin No. 11 of the Engineering Experiment Station of the College of Engineering of the University of Illinois, which is now in press. The data and results of tests cited here will be given in that bulletin in somewhat greater detail.*

From the point of view of the users of steam boilers the deposit of scale upon boiler tubes and sheets has importance for two reasons:

1. On account of its effect on the cost of maintenance and repairs.
2. On account of its effect on fuel consumption.

Concerning the first item, there is and has been comparatively little difference of opinion. It is quite generally conceded that in all boilers where scale forms to such an extent as to warrant consideration at all, it will result in increased leakage of flues and, in some cases, in deterioration of the boiler material. In the case of locomotive boilers, the increase in cost of maintenance is frequently less important than the loss of time caused by withdrawal of the engine from service.

Were the second item, namely, the effect of scale on fuel consumption, entirely removed from consideration, it is probable that the effect of scale on the cost of maintenance would in itself provide sufficient warrant for the great expenditure of energy which has been made to supply boilers with pure feed water.

The effect of scale on fuel consumption is, however, a subject about which there remain, after much discussion, noteworthy differences of judgment. It would not be correct to imply that it is not

*The writer is indebted to Professor L. P. Breckenridge, Director of the Engineering Experiment Station for permission to publish these tests in advance of the appearance of this bulletin.

generally conceded that scale reduces the evaporative efficiency of a boiler; but the amount of this reduction for deposits of ordinary thickness has been variously stated at from 25 or 30 per cent. down to amounts too small to be of commercial importance.

Since the second meeting of the American Railway Master Mechanics Association in 1869, the effect of incrustations in locomotive boilers has occupied the attention of that body at many of its annual meetings. Few attempts, however, have been made to actually determine the effect of scale on evaporative efficiency; and in most of the reported cases the data have been obtained under circumstances which render it impossible to eliminate uncertainty from the results.

In volume 10 of the proceedings of the Master Mechanics Association, for example, there are reported the results of 120 tests made on the Illinois Central Railroad to determine the effect of scale on fuel consumption. Statistics were compiled in each of these cases, for the locomotive in question, for 3 months preceding and for 3 months succeeding the cleaning of the boiler. For these 120 cases the general averages of the miles run per ton of coal before and after the removal of scale show an increase in favor of the clean boiler of 11 per cent.

It is not specifically stated in this report whether, in addition to the boiler cleaning, the locomotives underwent other repairs which, in themselves, would have tended to improve their general efficiency. The selection of the miles run per ton of coal as a basis of comparison is open to some objection; but the averages of so large a number of tests covering such periods of time would make this a fairly acceptable basis in this case. Other reported tests present similar uncertainties. Few cases are reported in which it is possible, from the data presented, to separate boiler and engine performance. Stationary boiler practice offers an opportunity for more easily obtaining reliable data concerning the amount of the fuel loss due to scale. Few tests have, however, been made with this point specifically in view, and fewer still are completely reported.

There is also some difference of opinion about the relation of this fuel loss to the thickness of the scale. It is quite generally assumed that the loss increases directly as the thickness. A statement made at one of the early meetings of the Master Mechanics Association, (vol. 7 of the Proceedings) that scale 1-16 inch thick results in an increase of fuel consumption of 15 per cent. has obtained wide currency. It was there further stated that this loss increases directly with the scale thickness—that ¼ inch scale would cause a fuel loss of 60 per cent. Neither statement rests on sufficiently accurate data. The following statement by Mr. William Kent in his "Steam Boiler Economy" represents the opinion of a considerable number of engineers:—"It is probable that the decrease of heat transmitted depends upon the kind of scale as well as upon its thickness, and that

it is not proportional to the thickness, but increases at a slower rate."

On account of such differences of opinion, and in view of the lack of reliable data on this question, the Railway Engineering Department of the University of Illinois determined in 1898 to undertake a series of experiments to determine the effects of boiler scale. The purpose of these tests was twofold:

1. To try to determine, in individual cases, the decrease in evaporative efficiency of boilers coated with scale—or the decrease in conductivity of single tubes so coated.

2. To attempt to establish the relation between the loss due to scale and the scale thickness.

Five series of tests have been completed, of which four are here reported. The first series consisted in a number of tests of a locomotive boiler before and after cleaning. The second, third, and fourth series were laboratory experiments with single tubes.

Test of Engine No. 420.

Series No. 1 was made in 1898. It consisted of an evaporative efficiency test of the boiler of Illinois Central Railroad Engine 420, before and after cleaning. As first tested this engine had been in service for twenty-one months. After being cleaned the engine was run in service for two days and again tested.

Conditions during all tests were maintained uniform in nearly all respects. The tests were made according to the boiler test code of the American Society of Mechanical Engineers, the start being made by the "standard method." All coal, water, and ash were weighed. The same fireman fired during all tests.

The average thickness of the scale on the principal heating surfaces may be stated as about 3-64 inch. The thickness and character of tube scale were as follows:

Near injector discharge—hard and soft scale, ⅛" thick. On upper tubes—smooth hard scale, 1-32" thick. On lower tubes—hard scale, 1-16" thick.

All scale removed was weighed. It was all removed from the tubes and as much as possible was taken from the shell and firebox sheets. The total amount taken out of the boiler was 485 pounds.

The results of the tests are given in table 1. The loss due to scale is calculated on the basis of the equivalent water evaporated from and at 212° Fahr. per pound of dry coal. The loss amounts, in this case, to 9.6 per cent.

TABLE NO. 1.

Results of Evaporation Test of Locomotive Boiler, Engine No. 420, Illinois Central Railroad.

First Series: After running 21 months and accumulating a scale deposit 1-32 to 3-64 inch thick.

Second Series: After cleaning and putting in new tubes.

	First Series Scale in Boiler			Second Series Clean Boiler		
Evaporative Performance.						
Date of trial (1898)	May 2	May 3	Mean	May 31	June 1	Mean
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Water actually evaporated per lb. of dry coal	5.21	5.27	5.24	5.81	5.85	5.83
Equivalent water from and at 212° F. per lb. of dry coal	6.29	6.39	6.34	6.99	7.04	7.01
Water actually evaporated per lb. of combustible	6.17	6.25	6.21	6.95	7.16	7.05
Equivalent water from and at 212° F. per lb. of combustible	7.46	7.59	7.53	8.36	8.61	8.48
Rate of Combustion.						
Dry coal burned per hour—						
Per sq. ft. of grate surface	57.45	58.51	57.95	59.80	60.00	59.90
Per sq. ft. of tube opening	394.80	402.10	398.40	411.00	412.80	411.90
Per sq. ft of water heating surface	.93	.95	.94	.97	.98	.97
Rate of Evaporation.						
Water evaporated per hour from and at 212° F.—						
Per sq. ft. of grate surface	361.80	374.40	368.10	418.00	416.00	417.00
Per sq. ft. of tube opening	2486.00	2573.00	2529.00	2874.00	2857.00	2865.00
Per sq. ft. of water heating surface	5.89	6.09	5.99	6.81	6.76	6.79

LABORATORY TESTS WITH SINGLE TUBES.

The last three series of experiments are referred to here as the series of 1901, 1904 and 1905. These tests were made with a number of single tubes coated with scale. Their purpose was to determine the difference between the conductivity of each scaled tube and that of a clean tube of the same length, diameter, and thickness.

The tubes were removed from locomotives which had been in operation in various parts of the South and Middle West. For each tube the thickness of scale was determined by calipering every six inches of its length. The scale was examined and characterized as either hard, soft, or medium; and for each tube a chemical analysis was made of the scale. Table 2 presents data concerning the tubes and the results of the scale analyses are given in Table 3.

Description of Apparatus.

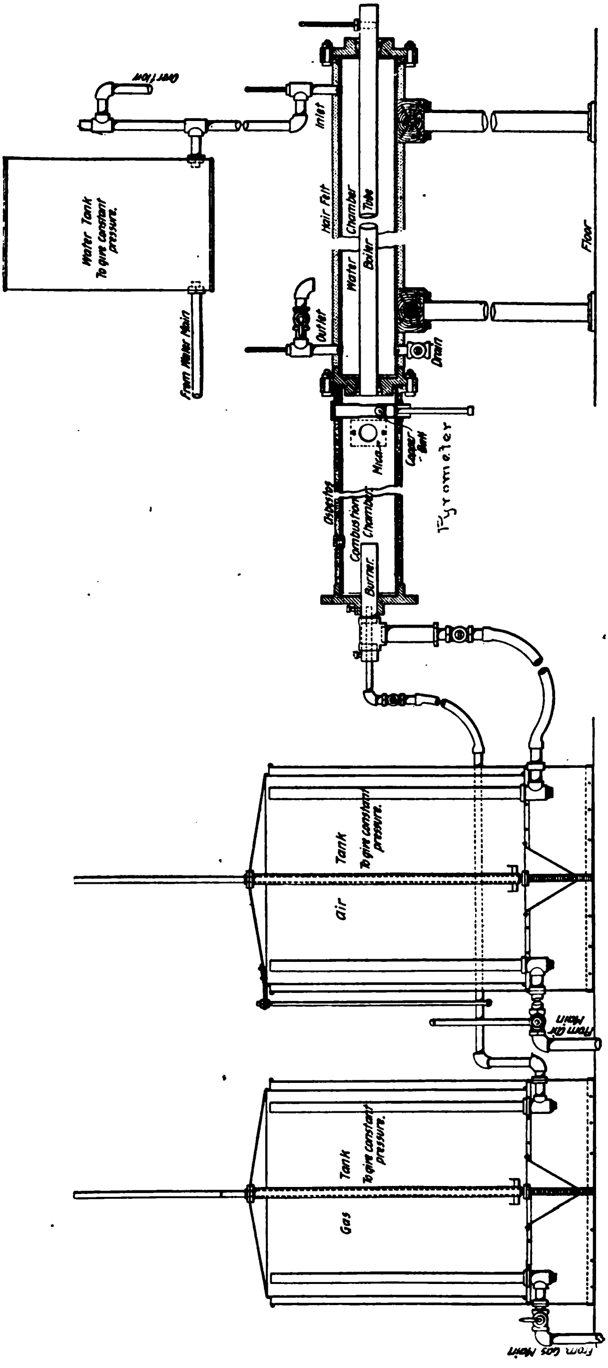
The apparatus in which the tubes were tested may be roughly designated as a single tube boiler or heater, and is shown in figures 1 and 2. It consisted essentially of a long water chamber, through which the tube to be tested was passed, and through which water was circulated. At one end of this water chamber was fastened a combustion chamber with which the tube communicated. The heat delivered to the tube was supplied by the combustion of gas in this chamber. The heat abstracted from the tube was determined by weighing the water which passed around the tube and through the water chamber, and by noting its rise in temperature. For each series of tests the gas and air needed for combustion were delivered to the burner at constant pressure for all tests, and in approximately the same amounts.

Figure 1 shows the general arrangement of the apparatus. The water chamber shown at the right consisted of a piece of pipe with flanged heads. A stuffing box in each of these heads permitted the tubes to be easily put in position. The tank shown above the water chamber, furnished the water supply and was arranged, as indicated, to maintain a constant head on the water chamber inlet. In the combustion chamber, immediately in front of the entrance to the tube, was placed the pyrometer, and the burner was located at the opposite end. Air and gas were supplied to the burner from the tanks at the left. Each of these was a small gas holder, consisting of an inner tank open at the bottom and floating on water contained in the outer tank. The pressure of the air or gas contained in the inner vessel could be varied at will by weighting the holder. For the series of 1901 a copper ball pyrometer was used. In the series of 1904 and 1905 this was replaced by a Le Chatelier pyrometer. Except as regards the pyrometer the apparatus was essentially the same in all three series.

Methods of Test and Results.

After adjusting the supply of water to the water chamber, the burner was lighted and the flow of gas and air regulated to the desired amounts. The apparatus was then allowed to run until all conditions had become stable. This usually required about one hour, at the end of which period the test was started. Observations were taken, at 5 or 10 minute intervals, of the temperature of the gases at entrance to the tube and at exit, as well as of the water temperature at entrance and exit of the water chamber. The amount of water used was determined by weighing.

The results of all tests are given in table 4. The purpose of the tests was to determine the number of British Thermal Units transmitted per hour through each tube. This equals the weight of water circulated multiplied by its rise in temperature, and these amounts are given in column 13 of table 4.



Apparatus to Show Heat Transmission Through Scale-Covered Boiler Tubes.

Fig. 1.

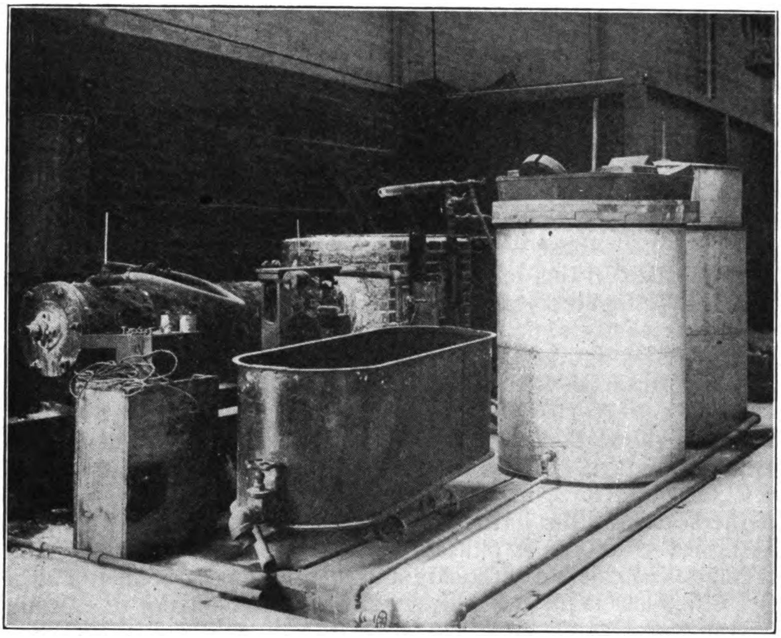


Fig. 2.
Photograph of Apparatus.

Had the mean temperature of the gases within the tube and the mean temperature of the surrounding water both remained constant throughout all the tests, these amounts of B. T. U. actually transmitted, as given in column 13, would provide a proper basis of comparison for determining the effect of scale. These mean temperatures, however, varied somewhat, as may be seen by an inspection of columns 6 and 9. These variations necessitate a correction of the figures in column 13.

The conductivity of the tube, or the B. T. U. transmitted per unit of time, varies directly as the range of temperature between the inner and outer tube surfaces.* This range of temperature is the difference between the mean temperature of the water and the mean temperature of the gases. Its values are given in column 12.† The amount of heat actually transmitted during each test is therefore reduced to what it would have been, had this range

*Preston—Theory of Heat. Edit. 1904, p. 629.
"In estimating this quantity of heat, the first principle that we make use of is, that the quantity of heat which flows through such a wall is directly proportional to the difference of temperature of its faces."

†The arithmetical mean of these entrance and exit temperatures is not the true average temperature of the gases and of the water during the period of test. For the conditions of the tests, however, no appreciable error is introduced by the assumption that this is so, and the calculations are simplified.

during all tests been the same as the average range existing during the tests of the clean tube. Column 14 gives the values thus derived, and these derived figures, compared with the heat transmitted through the clean tube, give the effect of the scale in each case. The difference between the heat transmitted through the scaled tube and that transmitted through the clean tube, expressed in per cent. of the latter, is given in column 15. The figures in this column represent the losses due to scale.*

In table No. 5 there is given a summary of the data and results of these tests. In this table the average loss due to scale is given for each tube together with its thickness and some of the chemical constituents of its scale. From table 5 there have been plotted four diagrams—figures 3, 4, 5, and 6—which exhibit the loss due to scale in relation to its thickness, its structure, and its chemical composition.

Figure 3 shows the loss due to scale plotted with reference to its thickness. Figure 4 is identical with figure 3, except that the letters H, S, or M have been added at the various points to indicate that the scale is either hard, soft, or medium.

In figure 5 the loss is plotted with reference to the sum of the percentages of calcium carbonate and magnesium carbonate, and in figure 6 this loss is plotted with reference to the amount of calcium sulphate.

In the series of 1901 there are a few tests which indicate an increase of conductivity of the scaled tube as compared with the clean tube. These are perhaps to be accounted for by errors in conducting the experiments, although they could not be detected at the time the experiments were made. The apparatus used in 1904 and 1905 was improved in some particulars, the most important change being in the means for the measurement of furnace temperatures. Such discrepancies disappear in the later series.

When the experiments were planned it was considered probable that the transmission of heat through the scale was principally dependent upon two of its characteristics, namely, its thickness and its mechanical structure and that probably, for such thicknesses as are usually met with, thickness had greater influence than structure. Thickness was therefore carefully determined and structure approximately designated as in table 2, as hard, soft or medium, no more

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*Considering the series of 1901, tube 11, test 24, the calculations are as follows:

	Tube 11	Clean Tube Average
Range of temperature—difference between mean temperature of gases and mean temperature of water	890.2	874.0
B. T. U. actually transmitted	26809.	29874.

B. T. U. which would have been transmitted had the range of temperature for tube 11 been the same as for the clean tube $= 26809 \times \frac{874.0}{890.2} = \ldots 26321.$

Loss due to scale $= \frac{29874 - 26321}{29874} = \ldots$ 11.9%

exact characterization of structure being possible with tubes collected from different sources, as these were.

It was hoped that the experiments might develop, if only approximately, some law of variation of conductivity with thickness. After making allowance for possible errors due to the method of conducting the tests, consideration of figure 3 shows perhaps a decrease of conductivity with thickness; but certainly no regularity of variation. In figure 4 the loss in heat transmission is again plotted with reference to thickness; and the structure of the scale, in so far as it was determined, is indicated as previously explained. No regularity of variation is observable with respect to hardness or softness.

In considering figures 3 and 4 it must be borne in mind that the tubes tested were taken from locomotives which had been in service in different parts of the country and that the scale on each tube was made up of the mineral constituents of many different water supplies. What is designated as hard scale in one case may be very different in structure—in porosity, for example—from what is designated as hard scale on another tube. Figure 4 cannot therefore be considered as providing conclusive evidence concerning variation of conductivity with structure. The results may properly be interpreted as indicating that mechanical structure is at least as important a factor in the change in heat transmission due to scale as is the mere thickness. Such a conclusion is, of course, in accord with the facts concerning other heat insulators.*

Figures 5 and 6, in which the loss in heat transmission is plotted with reference to the principal chemical constituents of the scale, do not warrant the conclusion that its chemical composition has any direct influence on its conductivity.

From the point of view of the physicist the experiments are open to objection as to method. From the engineer's viewpoint it is believed that the possible errors of the experiments do not, by any means, account for all the irregularity in the plotted results and, considering the controversy upon this subject and the comparatively meager information available, it is deemed proper to publish at this time the results as they stand, in the hope that they contribute additional information which may be of interest in some quarters.

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*In discussing the effect of structure it seems to be quite generally assumed that hard scale will reduce the conductivity of the tube more than soft scale. This assumption, moreover, is generally made without the reasons or data being adduced. It may eventually prove to be correct, but there are reasons for anticipating that, when the matter is settled experimentally, we may find that soft scale will cause the greater loss.

Water and vapors are known to be poor heat conductors. Experiments on the conductivity of metals by Fourier and others, in which the heat transmitted was measured by its absorption in water, proved that unless care was exercised to constantly remove the film of water next the metal, the low conductivity of this water layer so affected the results as to make it difficult to distinguish the effect of differences in thickness and nature of the metals themselves.

It seems probable that soft, porous scale would more effectively retain against the tube surface such a layer of water or vapor of low conducting power. Such facts seem to indicate that we should accept with caution the assumption that hard scale will cause a greater loss than soft scale.

Conclusions.

In so far as generalization is warranted we may sum up the results of the tests in the following conclusions:

1. Considering scale of ordinary thickness—say of thicknesses varying up to 1/8-inch—the loss in heat transmission due to scale may vary in individual cases from insignificant amounts to as much as 10 or 12 per cent.

2. That the loss increases somewhat with the thickness of the scale.

3. That the mechanical structure of the scale is of as much or more importance than the thickness in producing this loss.

4. That chemical composition, except in so far as it affects the structure of the scale, has no direct influence on its heat transmitting qualities.

TABLE No. 2

THE TRANSMISSION OF HEAT THROUGH SCALE-COVERED BOILER TUBES.

RAILWAY ENGINEERING DEPARTMENT, UNIVERSITY OF ILLINOIS.

Tube Number	Furnished By	No. of Engine from which Tube Was Taken	Length of Time in Service—Months	Outside Diameter of Tube—Inches	Average Thickness of Scale—Inches	Remarks. General Character of Scale, Etc.
1	2	3	4	5	6	7
				SERIES OF 1901.		
1	I. C. R. R.	311	10.5	2.0	0.06	Even, hard, dense.
2	P. & E. Ry.	526	13.5	2.0	0.04	Soft, porous, removed in places.
3	P. & E. Ry.	536	5.5	2.0	0.02	Hard, dense white.
4	C. M. & St. P.	126	....	2.0	0.03	Hard, dense white.
5	C. M. & St. P.	1,337	....	2.0	0.13	Hard, dense.
6	I. C. R. R.	820	5.5	2.0	0.07	Mileage during service, 19,690.
7	P. & E. Ry.	513	37.5	2.0	0.04	Hard, dense, rough, one end. Soft, porous at the other.
9	C. B. & Q.	1,179	....	2.0	0.11	Hard, porous, gray. Mileage, 50,889.
11	I. C. R. R.	1,107	21.	2.0	0.09	Soft, porous.
14	P. & E. Ry.	...	....	2.0	....	New and clean tube.
				SERIES OF 1904.		
1	I. C. R. R.	41	16	2.0	0.04	Hard, gray. In bad condition.
2	I. C. R. R.	41	16	2.0	0.07	Loose, gray.
3	I. C. R. R.	41	16	2.0	0.08	Loose, gray.
4	I. C. R. R.	141	15	2.0	0.05	White, porous. Removed in places.
5	I. C. R. R.	141	15	2.0	0.04	White, porous. Removed in places.
6	I. C. R. R.	141	15	2.0	0.08	White, porous.
7a	C. C. C. & St. L.	540	..	2.0	0.06	White, soft, irregular.
7b	C. C. C. & St. L.	540	..	2.0	0.06	White, soft, irregular.
8a	C. C. C. & St. L.	540	..	2.0	0.05	Hard, white, irregular.
8b	C. C. C. & St. L.	540	..	2.0	0.04	Hard, white.
9	I. C. R. R.	...	..	2.0	0.06	Hard.
10	I. C. R. R.	440	..	2.0	0.03	Hard, gray.
11	I. C. R. R.	440	..	2.0	0.09	Gray, porous.
12	I. C. R. R.	440	..	2.0	0.03	Gray, porous.
13	I. C. R. R.	...	..	2.0	....	Clean tube.
				SERIES OF 1905.		
3	I. C. R. R.	136	18	2.0	0.07	Medium.
4	I. C. R. R.	802	8	2.0	0.05	Hard.
8	C. C. C. & St. L.	533	10	2.0	0.03	Soft.
9	C. C. C. & St. L.	233	14	2.0	0.09	Very soft.
10	I. C. R. R.	1,424	10	2.0	0.07	Soft.
11	C. C. C. & St. L.	233	14	2.0	0.04	Very soft.
12	I. C. R. R.	140	21	2.0	0.07	Hard.
13	I. C. R. R.	303	18	2.0	0.02	Hard.
14	I. C. R. R.	1,004	21	2.0	0.04	Medium.
15	I. C. R. R.	1,012	12	2.0	0.03	Very hard.
7	....	...	..	2.0	....	Clean tube.

TABLE No. 3

THE TRANSMISSION OF HEAT THROUGH SCALE-COVERED BOILER TUBES.

RAILWAY ENGINEERING DEPARTMENT,
UNIVERSITY OF ILLINOIS.

Chemical Analyses of Scale

Constituents of Scale——Amount in Percent

Tube Number	Silica SiO_2	Oxides of Iron and Aluminum Fe_2O_3 Al_2O_3	Calcium Sulphate $CaSO_4$	Calcium Carbonate $CaCO_3$	Calcium Oxide CaO	Magnesium Carbonate $MgCO_3$	Magnesium Oxide MgO	Moisture	Organic Matter and Alkali
1	2	3	4	5	6	7	8	9	10
				SERIES OF 1901					
1	7.00	8.32	16.78	47.16	.....	1.30	11.20	1.18	7.06
2	5.68	8.98	27.30	22.27	10.45	.....	15.82	1.14	8.34
3	9.24	10.98	2.04	59.75	0.62	.....	10.18	0.64	6.55
4	9.80	15.92	25.86	23.20	3.02	.....	13.16	1.42	7.62
5	10.00	7.00	14.35	50.30	.....	8.40	7.30	0.84	1.81
6	7.42	4.26	16.08	51.44	.....	1.53	11.25	1.19	6.83
7	12.22	5.38	17.70	37.02	.....	0.79	16.76	1.63	8.50
9	12.46	11.24	36.85	21.37	.....	3.13	0.72	1.02	13.21
11	17.82	10.32	5.06	37.50	6.70	.....	13.92	2.25	6.43
				SERIES OF 1904					
1	26.04	10.80	1.36	27.50	3.84	.....	23.07	7.39	
2	17.21	8.02	18.50	11.52	.....	15.61	21.74	7.40	
3	15.10	3.95	21.93	10.48	.....	11.06	25.28	12.20	
4	8.90	1.90	22.81	49.11	.....	14.11	0.50	2.58	
5	9.11	2.20	47.96	16.85	.....	2.46	11.76	9.66	
6	12.10	2.60	54.99	10.78	.....	4.63	9.57	5.33	
7a	12.93	1.35	21.83	31.14	.....	5.14	15.94	11.67	
7b	12.93	1.35	21.83	31.14	.....	5.14	15.94	11.67	
8a	12.70	2.33	35.05	17.03	.....	3.99	17.85	11.05	
8b	12.70	2.33	35.05	17.03	.....	3.99	17.85	11.05	
9	23.52	7.20	6.56	37.56	3.48	.....	5.59	16.09	
10	10.05	6.47	11.71	50.98	.....	7.33	4.94	8.52	
11	9.75	2.08	6.05	54.71	.....	5.72	6.43	15.26	
12	7.98	4.68	8.89	55.61	.....	11.36	3.75	7.73	
				SERIES OF 1905					
3	7.09	5.05	17.16	19.45	.....	0.77	34.10	0.58	15.80
4	6.92	3.57	21.57	3.61	25.61	.....	1.85	0.56	36.31
8	6.61	1.34	0.62	74.26	.....	0.15	10.87	0.68	5.47
9	8.44	2.52	12.59	56.80	.....	0.33	11.43	0.87	7.02
10	3.33	1.43	5.82	67.99	1.64	.....	11.11	0.48	8.20
11	7.09	2.30	14.87	58.18	.....	2.22	8.26	0.75	6.33
12	27.72	9.53	12.11	10.05	0.24	.....	29.90	1.07	9.88
13	9.54	10.38	8.41	9.67	3.87	.....	39.09	0.71	18.33
14	16.87	4.73	2.22	40.30	6.06	.....	19.25	0.83	9.74
15	24.03	12.69	1.46	31.37	0.35	.....	20.91	1.45	7.74

TABLE No. 4

THE TRANSMISSION OF HEAT THROUGH SCALE-COVERED BOILER TUBES.

RAILWAY ENGINEERING DEPARTMENT, UNIVERSITY OF ILLINOIS.

			Average Temperatures During Tests — Degrees Fahr.											
			Of Furnace Gases			Of Circulating Water								
Tube Number	Test Number	Duration of Test—Hours	In Combustion Chamber	Of Escaping Gases	Average Temperature of Gases	At the Inlet	At the Outlet	Average Temperature of Water	Rise in Temperature of Water	Weight of Water Used During Test—In Pounds	Difference between Temperature of Water and Temperature of Gases—"Range of Temperature"—Column 6 Minus Column 9	B. T. U. Transmitted through Tube During Test	B. T. U. which would have been Transmitted had the Range of Temperature been the Same as for Clean Tubes	Decrease in Conductivity Due to Scale—Per Cent Loss
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SERIES OF 1901														
1	11	1	1657	256	957	66.9	112.7	89.8	45.8	651.3	867.2	29830	30063	*0.6
1	12	1	1702	252	977	66.8	112.6	89.7	45.8	643.3	887.3	29463	29021	2.9
2	16	1	1650	260	955	65.0	113.9	89.5	48.9	526.5	865.5	25746	25999	13.0
2	18	1	1631	269	950	64.1	110.3	87.2	46.2	584.0	862.8	26981	27331	8.5
3	1	1	1693	239	966	64.7	110.4	87.6	45.7	593.5	878.4	27123	26987	9.7
3	2	1	1690	238	964	65.7	111.0	88.4	45.3	600.7	875.6	27212	27162	9.1
4	20	1	1639	259	949	67.1	111.2	89.2	44.1	676.0	859.8	29812	30304	*1.4
4	21	1	1622	252	937	66.8	109.7	88.3	42.9	713.5	848.7	30609	31522	*5.5
5	6	1	1559	248	904	65.9	110.6	88.3	44.7	583.0	815.7	26060	27923	6.5
5	22	1	1702	265	984	63.9	109.3	87.1	45.4	624.0	896.9	28330	27606	7.6
6	3	1	1682	265	974	65.3	110.4	87.9	45.1	685.5	886.1	30916	30494	*2.1
6	23	1	1718	284	1001	63.6	110.7	87.2	47.1	646.0	913.8	30427	29101	2.6
7	8	1	1695	252	974	67.1	113.3	90.2	46.2	612.0	883.8	28274	27961	6.4
7	9	1	1693	256	975	66.9	112.0	89.5	45.1	669.5	885.5	30194	29802	0.2
9	4	1	1535	249	892	65.3	109.9	87.6	44.6	546.0	804.4	24351	26459	11.4
9	15	1	1597	252	925	65.8	110.9	88.4	45.1	505.0	836.6	22776	23794	20.4
11	7	1	1659	262	961	63.9	110.0	87.0	46.1	589.3	874.0	27167	27167	9.1
11	24	1	1683	271	977	64.1	109.5	86.8	45.4	590.5	890.2	26809	26321	11.9
14	5	1	1595	266	931	64.0	109.4	86.7	45.4	644.0	844.3	29238		
14	13	1	1690	267	979	67.8	114.0	90.9	46.2	650.2	888.1	30039	Clean	
14	14	1	1693	268	981	68.5	114.2	91.4	45.7	664.0	889.6	30345	Tubes	
Average			1659	267	964	66.8	112.5	89.7	45.8	652.7	874.0	29874		*Increase
SERIES OF 1904														
1	15	1	1432	648	1040	56.8	84.7	70.8	27.9	829.0	969.2	23129	22227	5.1
2	16	1	1439	659	1049	57.9	84.0	71.0	26.1	850.0	978.0	22185	21128	9.8
3	17	1	1436	667	1052	58.0	83.2	70.6	25.2	895.0	981.4	22554	21405	8.6
4	18	1	1418	515	967	57.7	80.4	69.1	22.7	975.0	897.9	22133	22958	2.0
5	19	1	1438	523	981	57.1	83.4	70.3	26.3	814.0	910.7	21408	21895	6.5
6	20	1	1439	511	975	58.3	82.7	70.5	24.4	865.0	904.5	21106	21734	7.2
7a	13	1	1439	647	1043	57.0	81.9	69.5	24.9	875.0	973.5	21788	20845	11.0
7b	14	1	1437	523	980	56.5	81.5	69.0	25.0	803.0	911.0	20075	20525	12.4
8a	12	1	1443	623	1033	57.0	89.4	73.2	32.4	662.0	959.8	21449	20812	11.1
8b	11	1	1414	593	1004	58.9	91.3	75.1	32.4	654.0	928.9	21190	21247	9.3
9	10	1	1423	547	985	57.6	83.8	70.7	26.2	767.0	914.3	20095	20471	12.6
10	7	1	1431	517	974	59.1	84.8	72.0	25.7	808.0	902.0	20766	21442	8.5
11	8	1	1415	536	976	58.8	85.1	72.0	26.3	735.0	904.0	19331	19916	15.0
12	9	1	1426	551	989	59.0	82.9	71.0	23.9	896.0	918.0	21414	21727	7.2
13a	6	1	1441	554	998	56.5	82.5	69.5	26.0	891.0	928.5	23166		
13b	5	1	1439	563	1001	56.7	85.1	70.9	28.4	825.0	930.1	23430	Clean	
13c	4	1	1440	569	1005	56.3	82.6	69.5	26.3	900.0	935.5	23670	Tubes	
Average			1440	563	1001	56.5	83.4	70.0	26.9	872.0	931.4	23422		

TABLE No. 4 (Continued)

1 Tube Number	2 Test Number	3 Duration of Test—Hours	4 Average Temperatures During Tests, Degrees Fahr. — Of Furnace Gases — In Combustion Chamber	5 Of Escaping Gases	6 Average Temperature of Gases	7 Of Circulating Water — At the Inlet	8 At the Outlet	9 Average Temperature of Water	10 Rise in Temperature of Water	11 Weight of Water Used During Test—In Pounds	12 Difference between Temperature of Water and Temperature of Gases—"Range of Temperature"—Column 6 Minus Column 9	13 B. T. U. Transmitted through Tube During Test	14 B. T. U. which would have been Transmitted had the Range of Temperature been the Same as for Clean Tubes	15 Decrease in Conductivity Due to Scale—Per Cent Loss
						SERIES OF 1905								
3	48	1	1783	873	1328	62.4	103.6	83.0	41.2	717.0	1245.0	29540	28722	2.8
3	49	1	1781	879	1330	62.4	102.1	82.3	39.7	753.0	1247.7	29894	29002	1.9
3	50	1	1798	867	1333	62.0	99.2	80.6	37.2	800.0	1252.4	29760	28764	2.7
4	45	1	1816	733	1275	62.2	102.6	82.4	40.4	699.0	1192.6	28240	28663	3.0
4	46	1	1809	715	1262	63.2	102.0	82.6	38.8	707.0	1179.4	27432	28155	4.8
4	47	1	1806	705	1256	63.3	102.4	82.9	39.1	692.0	1173.1	27057	27920	5.6
8	24	1	1788	740	1264	59.7	102.7	81.7	43.0	641.0	1182.8	27563	28220	4.5
8	25	1	1790	743	1267	60.1	102.4	81.3	42.3	660.0	1185.7	27918	28502	3.6
8	26	1	1805	743	1274	60.1	101.7	80.9	41.6	656.0	1193.1	27290	27688	6.3
9	27	1	1752	791	1272	59.9	101.1	80.5	41.2	683.0	1191.5	28140	28588	3.3
9	28	1	1753	800	1277	60.0	100.6	80.3	40.6	682.0	1196.7	27690	28009	5.2
9	29	1	1763	793	1278	59.7	100.6	80.2	40.9	695.0	1197.8	28426	28727	2.8
10	30	1	1772	786	1279	59.0	101.2	80.1	42.2	674.0	1198.9	28443	28718	2.9
10	31	1	1782	788	1285	58.8	101.8	80.3	43.0	663.0	1204.7	28509	28646	3.1
10	32	1	1783	792	1288	59.1	101.4	80.3	42.3	671.0	1207.7	28383	28449	3.8
11	34	1	1776	805	1291	67.1	103.1	85.1	36.0	767.0	1205.9	27612	27717	6.2
11	35	1	1785	803	1294	67.0	102.4	84.7	35.4	753.0	1209.7	26656	26674	9.8
12	37	1	1776	804	1290	64.5	102.1	83.3	37.6	747.0	1206.7	28087	28176	4.7
12	38	1	1785	790	1288	64.0	102.1	83.1	38.1	721.0	1204.9	27470	27598	6.6
13	39	1	1766	740	1253	60.2	101.4	80.8	41.2	679.0	1172.2	27975	28889	2.3
13	40	1	1754	748	1251	60.7	102.9	81.8	42.2	668.0	1169.2	28190	29190	1.3
13	41	1	1747	736	1242	61.2	101.5	81.4	40.3	695.0	1160.6	28009	29213	1.2
14	43	1	1805	808	1307	58.5	102.1	80.3	43.6	657.0	1226.7	28645	28267	4.4
14	44	1	1792	803	1298	58.8	102.9	80.9	44.1	645.0	1217.1	28445	28290	4.3
15	51	1	1804	759	1282	61.1	102.1	81.6	41.0	688.0	1200.4	28208	28445	3.8
15	52	1	1808	736	1272	60.8	100.9	80.9	40.1	701.0	1191.1	28110	28568	3.4
7	21	1	1792	794	1293	64.5	102.1	83.3	37.6	782.0	1209.7	29403	Clean Tubes	
7	22	1	1796	787	1292	64.2	103.6	83.9	39.4	754.0	1208.1	29708		
7	23	1	1808	784	1296	63.3	101.4	82.4	38.1	776.0	1213.6	29566		
Average			1799	788	1294	64.0	102.4	83.2	38.4	770.7	1210.5	29559		

TABLE No. 5

SUMMARY.

THE TRANSMISSION OF HEAT THROUGH SCALE-COVERED BOILER TUBES.

RAILWAY ENGINEERING DEPARTMENT,
UNIVERSITY OF ILLINOIS.

Tube No.	Test No.	Loss Per Cent	Avg. Loss Per Cent	Character of Scale	Thickness of Scale	$CaCO_3+MgCO_3$ in Scale	$CaSO_4$ in Scale	SiO_2 in Scale
			SERIES OF 1901					
1	11	*0.6	1.2	H	0.06	48.46	16.78	7.00
1	12	2.9						
2	16	13.0	10.8	S	0.06	22.27	27.30	5.68
2	18	8.5						
3	1	9.7	9.4	H	0.02	59.75	2.04	9.24
3	2	9.1						
4	20	*1.4	*3.5	H	0.03	23.20	25.86	9.80
4	21	*5.5						
5	6	6.5	7.1	H	0.13	58.70	14.35	10.00
5	22	7.6						
6	3	*2.1	0.3	[illegible]	0.07	52.97	16.08	7.42
6	23	2.6						
7	8	6.4	3.3	M	0.04	37.81	17.70	12.22
7	9	0.2						
9	4	11.4	15.9	H	0.11	24.50	36.85	12.46
9	15	20.4						
11	7	9.1	10.5	S	0.09	37.50	5.06	17.82
11	24	11.9						
			SERIES OF 1904					
1	15	5.1	....	H	0.04	27.50	1.36	26.04
2	16	9.8	....	S	0.07	27.13	18.50	17.21
3	17	8.6	....	S	0.08	21.54	21.93	15.10
4	18	2.0	....	S	0.05	63.22	22.81	8.99
5	19	6.5	....	S	0.04	19.31	47.96	9.11
6	20	7.2	....	S	0.08	15.41	54.99	12.10
7a	13	11.0	....	S	0.06	36.28	21.83	12.93
7b	14	12.4	....	S	0.06	36.28	21.83	12.93
8a	12	11.1	....	H	0.05	21.02	35.05	12.70
8b	11	9.3	....	H	0.04	21.02	35.05	12.70
9	10	12.6	....	H	0.06	37.56	6.56	23.52
10	7	8.5	....	H	0.03	58.31	11.71	10.05
11	8	15.0	....	S	0.09	60.43	6.05	9.75
12	9	7.2	....	S	0.03	66.97	8.89	7.98

*Increase.

TABLE No. 5 (Continued)

Tube No.	Test No.	Loss Per Cent	Avg. Loss Per Cent	Character of Scale	Thickness of Scale	$CaCO_3+MgCO_3$ in Scale	$CaSO_4$ in Scale	SiO_2 in Scale
				SERIES OF 1905				
3	48	2.8						
3	49	1.9	2.5	M	0.07	20 22	17.16	7.09
3	50	2.7						
4	45	3.0						
4	46	4.8	4.5	H	0.05	3.61	21.57	6.92
4	47	5.6						
8	24	4.5						
8	25	3.6	4.8	S	0.03	74.41	0.62	6.61
8	26	6.3						
9	27	3.3						
9	28	5.2	3.8	S	0.09	57.13	12.59	8.44
9	29	2.8						
10	30	2.9						
10	31	3.1	3.3	S	0.07	67.09	5.82	3.33
10	32	3.8						
11	34	6.2	8.0	S	0.04	60.40	14.87	7.09
11	35	9.8						
12	37	4.7	5.7	H	0.07	10.05	12.11	27.72
12	38	6.6						
13	39	2.3						
13	40	1.3	1.6	H	0.02	9.67	8.41	9.54
13	41	1.2						
14	43	4.4	4.4	M	0.04	40.30	2.22	16.87
14	44	4.3						
15	51	3.8	3.6	H	0.03	31.37	1.46	24.03
15	52	3.4						

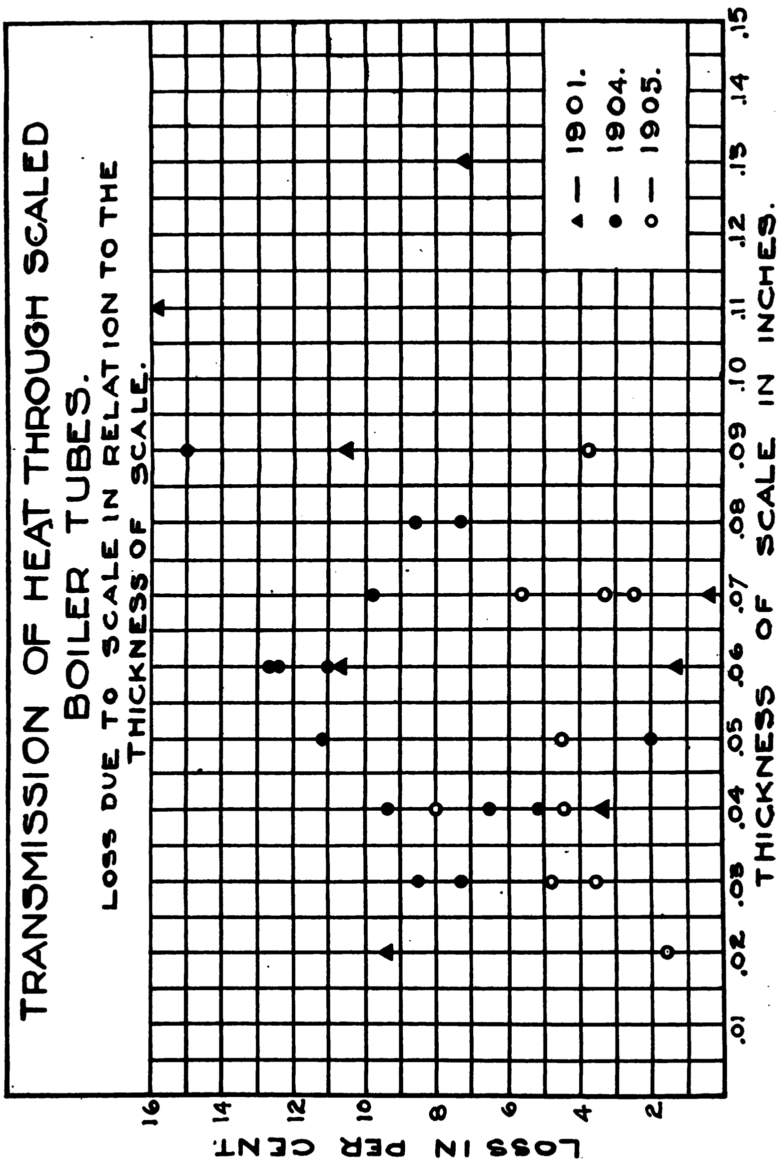
TRANSMISSION OF HEAT THROUGH SCALED BOILER TUBES.
LOSS DUE TO SCALE IN RELATION TO THE THICKNESS OF SCALE.
▲ — 1901.
● — 1904.
○ — 1905.
LOSS IN PER CENT
2 4 6 8 10 12 14 16
THICKNESS OF SCALE IN INCHES
.01 .02 .03 .04 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15

Fig. 3.

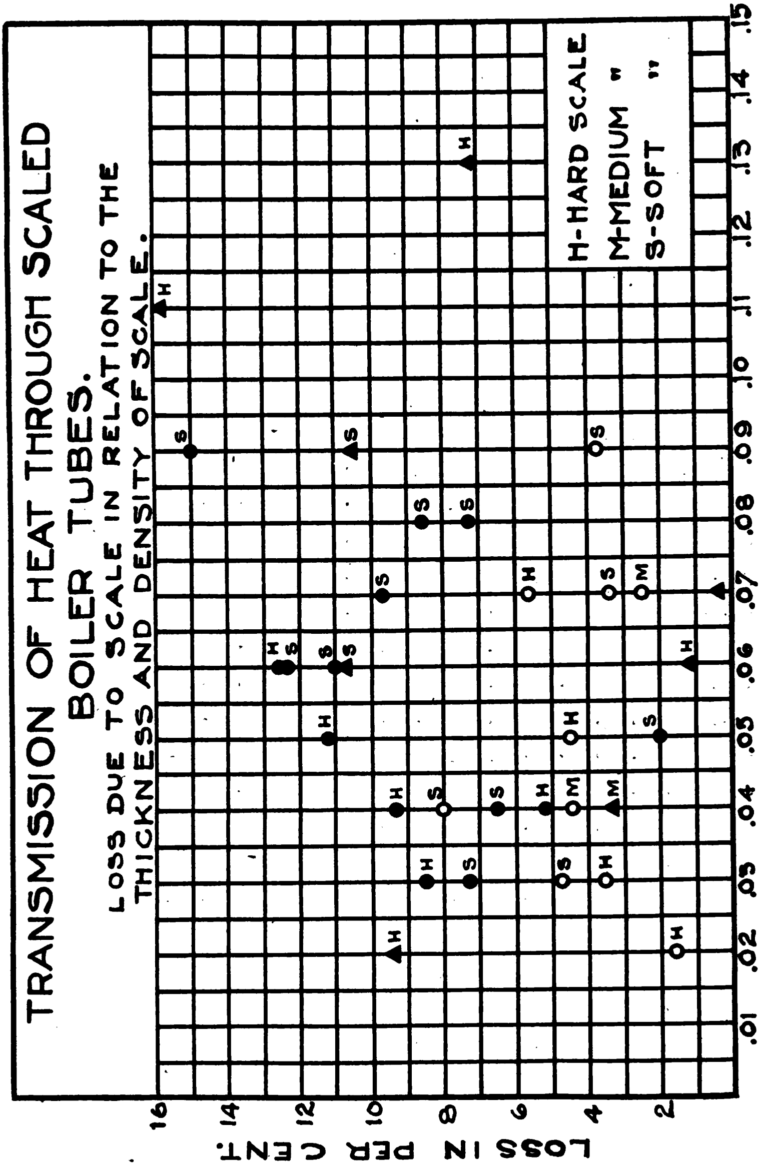
TRANSMISSION OF HEAT THROUGH SCALED BOILER TUBES.
LOSS DUE TO SCALE IN RELATION TO THE THICKNESS AND DENSITY OF SCALE.
H-HARD SCALE
M-MEDIUM "
S-SOFT "
THICKNESS OF SCALE IN INCHES.
LOSS IN PER CENT.
.01 .02 .03 .04 .05 .06 .07 .08 .09 .10 .11 .12 .13 .14 .15
2 4 6 8 10 12 14 16

Fig. 4.

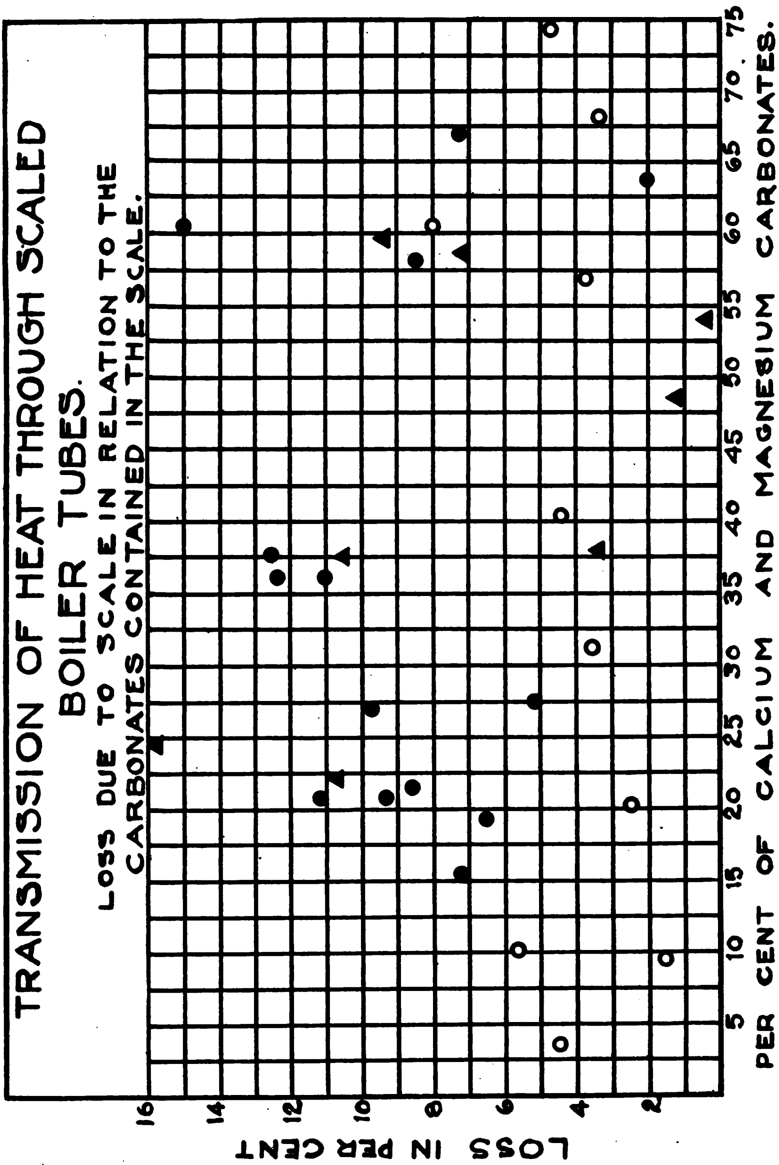
TRANSMISSION OF HEAT THROUGH SCALED BOILER TUBES.
LOSS DUE TO SCALE IN RELATION TO THE CARBONATES CONTAINED IN THE SCALE.
PER CENT OF CALCIUM AND MAGNESIUM CARBONATES.
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
LOSS IN PER CENT
2 4 6 8 10 12 14 16

Fig. 5.

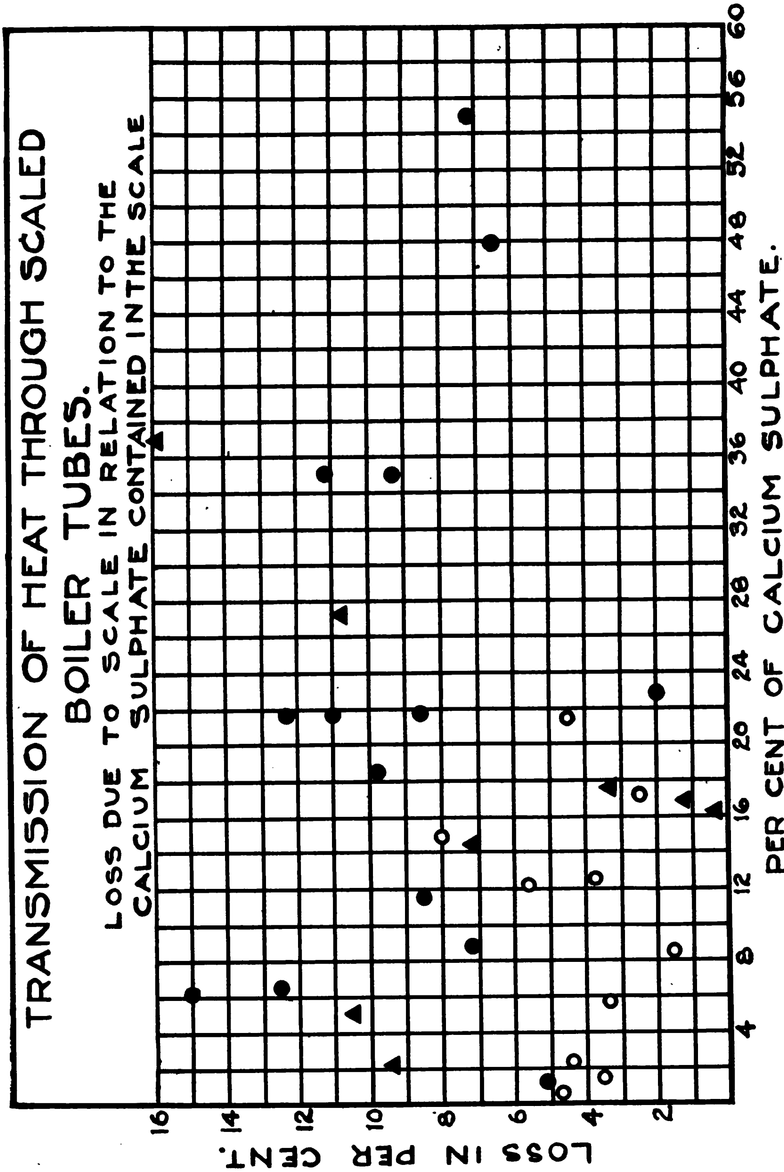
TRANSMISSION OF HEAT THROUGH SCALED BOILER TUBES.
LOSS DUE TO SCALE IN RELATION TO THE CALCIUM SULPHATE CONTAINED IN THE SCALE
LOSS IN PER CENT.
16
14
12
10
8
6
4
2
PER CENT OF CALCIUM SULPHATE.
4
8
12
16
20
24
28
32
36
40
44
48
52
56
60

Fig. 6

The President: Gentlemen, you have heard the paper by Prof. Schmidt; it is open for discussion. Any questions that may be asked will be answered at the end of this discussion. If we have any gentlemen here who are in the habit of using good water, they need not talk very much about this subject, but I think we have plenty in the hall who are bothered with scale forming waters and we would like to hear from them. There is enough talent in the room to give us information about this subject. During the last winter I know a great many of us had engines tied up in the round house due to the fact that the flues were all coated with scale so that we had to have them taken out and renewed. I do not think that is a novelty to any of us, especially to Mr. Manchester, who must have had one or two cases of that sort, and if so, we would like to hear from him.

Mr. A. E. Manchester (S. M. P., C. M. & St. P. Ry.): I hardly think that it is necessary for the President to make reference to any particular person, because I think there are a great many people in the room that could give some experience along those lines.

It is of interest to all engineering and mechanical people to have put before us some rule or guide to demonstrate, or demonstration to show about what the results of these different conditions are. It but calls to our attention perhaps more vividly than we might see it otherwise the great losses that are caused by scale on the heat parts of the boiler and it appears to me to bring out with more force the fact that there is hardly a limit to which a railroad can afford to go in order to get away from waters that are scale-forming waters and also at the same time to get to waters that do not require treatment in order to make them good.

At the last Master Mechanics' Convention held at Old Point Comfort, I think it was eight years ago, I was chairman of a committee that had to deal with the question of feed waters and in that the report said that a railroad should spend very large sums of money to get waters that were not scale forming and some railroads that I know of have taken advantage of that condition wherever it was possible, with wonderful success. I think possibly that some members from the C., B. & Q. Ry. can give us some facts on what they have done and spent along their Mississippi lines to get good water. The Mississippi river water is considered by everybody as good water and yet, if my information is correct, the C., B. & Q. Ry. spent a large amount of money to go to the channel of the river for water; they were not satisfied to go into the river, but they went to the channel to get their water, and I believe that that points out more vividly the experience that we have all had in looking for good feed waters, that in almost all cases the best place to go is to running streams and to the channel for water. My thoughts are all in the direction of the possible benefits that can accrue to railroads by either

getting first class water, or where that can not be had, to take such other known means as there are to get water into their boilers that is not scale-producing.

The President: I am not familiar with what the C., B. & Q. Ry. has done along the lines mentioned by Mr. Manchester, but if we have any member here who is familiar, we would like to hear from him. Mr. Wickhorst, may we hear from you?

Mr. M. H. Wickhorst (Engineer of Tests., C., B. & Q. R. R.): I can give a little information about that, but before taking it up I want to remark that this paper deals particularly with the losses due to lessened conductivity of the scaled tubes, but probably a more important loss than even the loss of conductivity is the loss occurring from leakage when the tubes are scaled, as leakage loss is probably more important in actual loss of coal than even the loss of conductivity. If, with our big engines, high pressures and hard service we could keep scaled tubes tight, probably we would not concern ourselves much about the other losses; but unfortunately, (or possibly fortunately), it seems that no method has been brought out by which we can have tubes scaled and also keep them tight. Those two conditions do not seem to go together except in the smaller classes of engines.

Going back to the matter mentioned by Mr. Manchester, I may say that some years ago, the C., B. & Q. Line along the Mississippi river in Wisconsin took its water supplies largely from wells on the Mississippi river banks. These wells are at the base of the bluffs and are supplied largely from springs, as it were, that is, the supply comes largely from the bluffs through the ground and the flow would be into the well and out into the river. The assumption of the engineers who originally built the road apparently was that the seepage would be from the river into the well. Of course the head being from the bluffs, naturally the water would go into the river rather and even where there is a direct pipe connection from the well into the river, if the water is taken out of the well we will always get at least some of the ground water just the same, simply because the flow is from the well into the river and not the other way. All that well water is somewhat harder than the river water, although it is not such very bad water. Most of those supplies have been changed so as to get the water from the river direct instead of from the well. The Mississippi water is rather soft up north, still it contains a little encrusting matter and more particularly some calcium sulphate, which forms a particularly hard scale and even if there is only a small amount in the water, it keeps accumulating somewhat. It has the property of not being thrown out of solution very quickly, so that it gradually accumulates on the tubes and even if there is only a small amount it can form as bad a scale as if there was considerable in the water, although it takes somewhat longer to form.

The program entered into something like two years ago was to treat the water supplies of that division with sufficient soda ash to counteract the calcium sulphate. Instead of allowing the calcium sulphate to form a hard scale, the result of soda ash if it is used in proper amount is to convert all the scale forming material into a sludge making material which can be eliminated, and the tubes thus kept perfectly clean.

As I said, something like two years ago arrangements were made to treat the water supplies with soda ash and it was put into the waters at the pumping station and its amount regulated by chemical analysis. I stated that the effect of the soda ash was to bring the material all down in the form of sludge and part of the program was to provide the engines with a blow-off arrangement that would effectively remove the sludge from the boiler. The natural circulation in the boiler carries all light material, mud, etc., into the back water leg where there is a quiet space of, perhaps one or two cubic feet, in which mud, etc., can collect, and if that is kept clean by an effective blow-off arrangement, the circulation will carry all the sludge and all the lime and other material into that place where it can be blown off. While soda ash has this very good property of preventing scale formation, when it is used in proper quantity, it has also the very disagreeable feature that it makes the boilers foam. Then that in turn requires that considerable blowing off be done, and as a matter of experience we find that if the water in the boiler is kept below the concentration of 200 parts dissolved solids per 100,000, which would be about 100 grains to the gallon, the frothing tendency of the water is kept down below a point where it can do any harm, that is, where the water does not froth over and get into the cylinders. Then also by chemical inspection we have arranged to see that the blowing off is carried out so as to keep the water below the foaming point, and the result of this combination of getting a better natural supply and then treating it with soda ash and arranging the blow-off, equipping the engine with proper and suitable blow-off arrangements and then arranging to blow off at the terminals, and further, looking after the round-house flue work, as a combination result of all that, I may say that on this one particular division we have gone through the year 1906 with but one engine failure due to a leaky boiler. The number of engine failures due to leaky flues on this division during the last four years was as follows:

	1903	1904	1905	1906
Failure due to leaking flues.......	160.	132.	41.	1.

THE PRESIDENT: That certainly is a remarkable record. Mr. Wickhorst says that either fortunately or unfortunately the scale on the boiler tubes makes the engine leak sometimes. I will say it is very unfortunate where it keeps them tied up very long. In

regard to soda ash in the Mississippi water, I would like to ask Mr. Wickhorst about how much he uses per 1,000 gallons?

MR. WICKHORST: It would be perhaps two parts per 1,000, say one-fifth pound per 1,000 gallons in that particular water. We have all sorts of waters up there, some of them requiring as high as one-half pound per 1,000 gallons.

THE PRESIDENT: Would you think 16 pounds of soda ash in a 5,000 gallon tank of Chicago water would be too much or too little, —in Lake Michigan water?

MR. WICKHORST: Sixteen pounds of soda ash, yes, it would be too much by a good deal.

THE PRESIDENT: I am just asking that because our boiler maker and round-house foreman are here and I want them to hear this. They put that much in and I want this brought out for their benefit. Mr. Jeffries as an engineer, do you have any trouble with scale on the tubes or in the fire-box?

MR. B. H. JEFFRIES (Wabash R. R.): I have had lots of them, but I do not believe I can add anything that would interest the members here tonight. Mr. Wickhorst's remarks about blow-off cocks struck me as an interesting point. A great many railroads have equipped their engines very nicely with blow-off cocks and have made very stringent rules regarding their use, but I have the first time in my life to see where those rules are carried out to the letter and where blow-off cocks are used as they should be used. I believe that if an engine is properly equipped with blow-off cocks, and they are properly used, that you can get along in many cases without washouts and even do better, get more stuff out of the boiler, than by using a scale solvent when blow-off cocks are not frequently used.

I remember not long ago the question of using blow-off cocks was brought up. The reason they are not used is only a question of time. It does not do any good to use the blow-off cock while the sludge in the boiler is in circulation; to get good results the engine should be allowed to rest at least thirty minutes, the air pump shut off, with absolutely no circulation at all, then open the blow-off cocks and you will get some benefit. I believe if the blow-off cock feature had more attention and it were used properly, that great results could be obtained from that one feature alone.

MR. WICKHORST: I want to say that while this one division has done such good work, I do not want to give the impression that the whole C., B. & Q. System is in that shape. This one division, though, I might add as a matter of information, is running between washings, getting a mileage of something between 3,000 and 4,000 as an average out of the engines on that division. In the month of January or December, I have forgotten the average of all divisions on our engines, but on that division it was pretty close to 4,000 miles between washouts.

THE PRESIDENT: There is no doubt that what Mr. Jefferies said about the use of the blow-off cock is absolutely true. The blow-off cock should be used with bad water so as to carry out the sludge that is thrown down in the boiler. Probably if we were to make the water foam so badly in the boiler that the engineers would have to use the blow-off cock for self-protection, we might get better results. Prof. Goss unfortunately was unable to be here tonight, but he sent a representative in the person of Mr. Wallace whom I feel sure the members present will give the privilege of addressing us if he has anything to say on the subject of scale on boiler tubes in connection with the Schenectady engine that they have on their testing plant.

MR. L. W. WALLACE (Purdue University): Mr. President and Members of the Western Railway Club,—I represent Prof. Goss by occupying a seat only, and in no other respect.

With reference to scale forming waters, I think the experience through the year has been that very little trouble arises through the formation of scale, and the boiler is washed out very seldom compared to road service. We have no trouble with our boiler foaming and the blow-off cocks are never used. Owing to the fact that the water is comparatively good no solvent is used.

THE PRESIDENT: Gentlemen, this is a very interesting subject. I have a few things to say after everybody else has exhausted their energies. Mr. Kelly, as a boiler maker, what trouble do you have with scale on boilers? Do you ever have any trouble in that connection? Does it interfere with heat transmission, or how does it affect you?

MR. J. W. KELLY (Foreman Boiler Maker, C. & N. W. Ry.): Mr. Chairman and Gentlemen. Scale affects the boiler work more than any other thing, I believe. I have found in boilers, scale from 3/8 to 5/8 inch thick. We had a plant on the Mississippi which gave a great deal of trouble leaking, because of heavy scale. The water was changed to river water, and the boiler stopped leaking. The water was taken from the channel as brought up by Mr. Manchester. The greatest trouble I find is where the engines are changed to different kinds of water, or from one division to another district where the water is different. If the engine has been running in a hard water district and is changed to a softer water, the scale peels off in quarter or probably half the circle of the flue and lodges in the water space. Especially so, where the bridges are narrow. Then the soft water coats it all over like cement, then it becomes hard and solid and it is impossible to wash it out. The only way it can be removed is to remove the flues. Soda ash will not help this kind of a case whether you put in 16 lbs. or 1/2 lb. to a tank of water.

I know soda ash when used properly in connection with the blow-off cock is a very large help to keep boilers from scaling and leaking. Good feed water is what we want whether we get it from the channel of the Mississippi river or any other river.

The President: Mr. Davidson, you have had a great deal of experience in transforming bad water into good water and helping us out of our troubles? Can you tell the members present anything about this subject, or throw some light on it?

Mr. G. M. Davidson (Chemist C. & N. W. Ry.): This is a subject that has interested me very much. I want to compliment the Professor on showing some figures that we can depend upon. We have had all sorts of statistics published, showing the loss of heat due to the non-conductivity of boiler scale, but so far as I know these are the only figures which are based on actual experiments and that can be considered at all reliable.

In looking over the Professor's figures, the thing that strikes me most is the fact that he did not have very much scale on those flues; some of them had 2-100 inch; I think that is pretty light. The most that we find in looking through the tables, is 12-100 inch, about 1/8 inch. Now, as Mr. Kelly says, we have had some that are 5/8 inch. I have a piece of scale on my table in my office that is off a crown sheet that is 3/4 inch thick.

We find several kinds of scale in boilers and in order to illustrate, I put in my pocket when I left my office to-day two or three pieces. We sometimes find scale like that (indicating specimen) which is about 1/4 inch thick. It is smooth, like a piece of porcelain, and forms so tightly around the flues that you have to take a hammer to get it off; you cannot scrape it away. I have a flue in my office that has 1/2 inch of this on it; this particular piece happens to be about 1/4 inch.

The President: Pass it around, Mr. Davidson.

Mr. Davidson: Yes, I will pass both in a minute. Then we find another kind which is soft, this you can rub away, you can take your finger and rub this off; it is very porous, almost granular, whereas the other is just like a porcelain plate.

The character of the scale on the flue, we think, determines somewhat its ability to conduct heat. We think a scale that is fixed on as tight as that one and is as closely made up will not conduct heat as much as this one which is very porous. The water will go through this and get on the flue, while very little water will go through that. When we take boilers into the shop, we find some curious things. I sawed this off (indicating another specimen) from a piece about two feet long. It shows the marks of four flues, two on one side and two on the other. This was taken from an engine that runs from a division point in four directions, north, south, east and west. The water on the line running east from the division point is hard water; the water on the lines running in the other three directions is soft water. The engine runs on the Eastern line for a week, we will say, and the flues get coated with the scale perhaps 1/8 inch thick, perhaps not so much. Then it goes to one of the other lines for a

week; that scale drops off and lodges between the flues; it cannot get down through because the flues are so close together. The engine goes back again to the hard water district and the hard water cements those pieces together. I will pass this around and you will see that it is made up of a lot of small pieces cemented together. There are three exhibits here, one is a smooth piece of scale, another is a porous piece of scale and the third is agglomerated scale made up of a lot of pieces.

I have seen some curious looking flues that have been coated. I have in mind a case where a locomotive ran between a station on the Missouri river and a station back in the country hauling a short passenger train, making a trip back and forth every day. The water supply at one station was from the Missouri river, which is muddy all the time; it has always got sand in it. At the other station the water was from a well that contained a great deal of calcium sulphate. The combination made a pretty good cement and when that engine came into the shop at one time, I saw some flues taken out of it that had ⅝ inch hard scale on them. It was necessary to take a hammer to break it off; it could not be scraped off.

THE PRESIDENT: I think it might be advisable to send a few tubes to Prof. Schmidt and have him see what results he can get where the scale is ⅝ inch thick.

Very little has been said this evening about the delays to engines, the way that engines are tied up on account of having to hold them in to remove this scale, and I would like to ask if somebody can give us information in that direction. Mr. Barnum, can you give us any data on the loss of power that accrues due to the taking of bad water, causing power to be out of service more than it would be by taking good water?

MR. M. K. BARNUM (C., B. & Q. Ry.): I can give you one good example which occurred on the Union Pacific. For many years after the road was built through Wyoming, the water at Rawlins was so bad that the flues in the stationary boilers and switch engines became so heavily coated with scale that they had to be changed every three months, and fire-boxes had to be renewed about every nine months. The management finally came to the conclusion that the loss of engine service and other expenses caused by the bad water were so excessive that they could afford to spend a great deal of money to obtain good water. Of course it was known that there was a large loss of fuel value in the coal used in these boilers, but that was not readily measured and proximity to the mines made fuel cheap and these losses seemed less serious than the cost of changing flues and fire-boxes and the loss of use of the power. The nearest good water that could be found was 12 miles away in the Platte River, which at that point was principally melted snow from the adjacent mountains, and eventually a 12-inch pipe line was laid with 2

or 3 pumping stations. They have been pumping water from the river twelve miles to Rawlins for five or six years, with the result that those same switch engines now run two years without change of flues and the road engines are benefitted in proportion to the amount of Rawlins water used.

Within the last few years railroad companies have appreciated more than formerly the value of good water, both on account of the reduction in boiler work and on account of the saving of fuel, but I doubt if any of us have realized that it is possible to save as high as 10 or 11 per cent of the fuel by having good water and consequently clean flues and fire-boxes.

This a most valuable paper and the records are so significant that they should stimulate further investigation and if necessary, the Master Mechanic's Association should appoint a committee to carry these experiments on until definite formulae are obtained, determining the proportional fuel losses as the scale increases. Such records will enable the railroads and other users of steam to determine how much they can afford to spend in improving the quality of water for boilers. I believe that if this data were available now it would be so easy to show the management of many railroads a saving by improving the quality of water that immediate steps would be taken to obtain the best quality of water available.

The President: I think that is a very good suggestion, Mr. Barnum. I feel sure if we could say absolutely what we could save in dollars and cents, and go to our management with those figures and know beyond a doubt that they were accurate, there would be very little difficulty in getting an appropriation for the benefit of our water supply. The trouble is with a good many of us now, we say. "Well, we have got a lot of scale on those flues and we are wasting a whole lot of coal." Well, that "whole lot," is a very indefinite quantity, one does not know whether it means two or three hundred pounds or several tons. If we go to the management and ask for an appropriation of $20,000 to purify the water we ought to be able to give more definite information than to say "We are wasting a whole lot of coal."

The statement about the switch engines was rather interesting to me, because we had an experience in the other direction. When I was Master Mechanic at Clinton, we had a well very close to the river that contained a very soft water suitable for boiler use, and it was nothing unusual for us to run our engines four or five years without touching the fire box and when we took the flues out, they would be practically as clean as the day we put them in. A little later on it became necessary for us to move our engine house from close proximity to the river to about a mile west of that point and we sunk a well there with the hopes that we would get a similar quality of water to what we were getting down by the river, but we

were very much surprised and disappointed after using the water to find out that it was so heavily charged with scale forming matter, that the tubes would not last more than eight or nine months in our engines, so that while it was in the same town and only a mile difference, we evidently got down to a depth that did not put us in communication with the strata that we had been getting the water from before.

Mr. Barnum: I would like to add to what I said that it should be borne in mind that this water taken from the Platte River was taken close to the mountain; it was largely snow water, and that the Platte water farther down is of very different quality and is not at all desirable.

The President: The paper presented tonight interests us more on account of the first subject here, or the first paragraph, on account of its effect on the cost of maintenance and repairs. Now, those are the things that we see every day in going around the shops. The effect on fuel consumption with a good many of us is not so readily conceived. Now, when we see, as I have seen in the last few months, 27 out of 30 engines being taken out of service for nothing else but the removal of flues so that the scale could be taken off them, it is brought very forcibly to my mind that something is radically wrong, and therefore, as I say, this first paragraph appeals more to me than the fuel saving to show really what can be done about getting water that has had the scale forming deposits taken out of it.

I have a letter here from a master mechanic who has been using purified water for some little time and he gives me a statement showing the saving that has been made in various directions, among others beiny that originally, before the water purifying plants were put in, he had 36 boiler makers costing $10.40 an hour, and 42 boiler makers' helpers, costing $7.09 per hour, while after the water purifying plants had been in operation probably 18 months to two years he says he has only 23 boiler makers instead of 36, at an average of $7.71 per hour, and 35 boiler makers' helpers at $6.70 an hour, instead of 42. This means that they have decreased their boiler making force 56 per cent. With the difficulty we are having in getting boiler makers at the present time, gentlemen, that speaks volumes. He says: "This is not the only result, however, that has been produced, that is, the decreased number of boiler makers. The other beneficial results from the treated water are that it has enabled us to keep our engines in such condition that the number of engine failures has dropped off to a remarkable degree." And further he shows that the number of engine failures due to leaky fireboxes and flues decreased 30 per cent; he also shows that, due to the fact that the engines did not give up their train as frequently under the new conditions as the old, he was able to make a much better showing on ton mileage handled. You all know that if an engine starts out and begins leaking, they

have to peddle the train out, and wind up by coming in with the way car only, which is not a very satisfactory performance, but here, with the improved condition, the increased tonnage was remarkable. It also is done at a very much decreased cost for coal. He shows here that he handled an increase of 6.6 tons mileage with a saving of 4 per cent in the number of engines, so that question of good water appeals to me more in the direction of something that I can see than something that I can only tell is gained. Mr. Forsyth, you have given this matter a great deal of study; we would be glad to hear from you if you have anything to say.

Mr. Wm. Forsyth (Railway Age): Mr. President, I have been very much interested in this subject and I am glad that Prof. Schmidt has prepared this paper and I hope that the University will continue the work.

The results obtained thus far are rather indefinite and the most discouraging conclusion is the third one which says: "That the mechanical structure of the scale is of as much or more importance than the thickness in producing this loss": that is, that it is going to be difficult to define how much loss there is due to one eight or one quarter inch scale if you cannot define the quality of the scale, although there may be some approach to it by calling it hard or soft or medium or something of that kind. I hope that since the University has started out on this work,—they have been at it about nine years now, and they have the apparatus, they have the enthusiasm and they have found out what difficulties there are in conducting the experiments, and I hope they will continue until they get some definite results. Mr. Davidson has suggested one reason why they have not, and that is because they have dealt with such small thicknesses of scale and such small differences and with these conditions it is difficult to get any accurate, definite values. I should think that in the further work of the University in this direction, if they were to apply to Mr. Davidson, or some road where they are making thick scale, that they could get tubes with the ¼ inch hard scale, ¼ inch soft scale and other tubes with pretty uniform coating of ⅜ or ½ inch and then dealing with these large thicknesses and definite compositions, they could gradually work out some rather definite results.

The other objection that might be made to the experiment is the small range of temperature. I am not exactly clear as to what difference that would make, but the apparatus is simply warming the water, it increases the temperature about 40 degrees, and is not boiling water under pressure of 200 pounds as in locomotives. It may be that that is not a valid objection, but I should think if they would deal with larger differences in temperature they would be apt to get more definite results. Another experiment I hope will be made with this same apparatus, is, that they arrange to force the evaporation from a clean tube to the maximum and see what is the

highest possible evaporation per square foot of heating surface that can be obtained under the most intense heat and under the most active circulation of water. That is something we do not know very much about and it is in the direction which boiler operation must take in order to make any advance.

MR. E. S. WOODS (W. B. Scaife & Sons Co): I have some figures which may be of interest to the Club. We have in our business heard a great deal about how much scale would retard the transmission of heat and a good many of the assertions have been apparently rather wild. We have in one case, however, taken five months' test on a boiler scaled and a boiler with absolutely clean flues and sheets, and I have the figures showing the relative coal consumption. The plant in question is stationary and of 175 H. P., being located in the southern portion of Ohio. It is run 24 hours a day. The tests were made during January, February, March, April and May, 1905, and during the corresponding months in 1906, the first being with the foul boiler and the second with the perfectly clean boiler due to treated water. The total coal consumption during the first period was 1,455,932 pounds, and during the second period was 1,134,740 pounds or a difference of 321,192 pounds, or something like 160 tons of coal. The figures show an approximate decrease in coal consumption of a litttle over 22 per cent. We are unfortunate in not being able to state to you just what the thickness of scale was. Of course that is a very important factor and I have no means of giving you anything on that point; also it varies at different portions of the boiler. I may add that during the period of 1906 the plant was worked at a slightly increased capacity, not very much.

THE PRESIDENT: Mr. Forsyth regarding the suggestion you made about furnishing Mr. Schmidt with a tube having heavy scale on, I think if we will hunt around about two minutes we will be able to find several people who can furnish such a tube.

In regard to Mr. Woods' statement that there was a saving of some thousands of pounds of coal, it is rather indefinite unless we know just exactly the total boiler output in each case. You say there was a little more work done one year than another. We should, before we are able to come to anything very definite about it, know just what increase of output was attained from those boilers under the different conditions.

MR. WOODS: I cannot state just what the increased output was that was obtained from the boilers. The only information that I have on the matter is the statement of the owners of the boilers to the effect that "We have slightly increased our load since December, 1905, making a saving of somewhat more than the figures show," but from my knowledge of the conditions I can say that the increased load was not material, probably not to exceed four or five per cent at the very outside.

MR. JEFFRIES: I would like to ask Mr. Woods whether or not this test was made with the same firemen in both cases, or whether there was a change in the men? It seems to me that that would materially affect a case of this kind.

MR. WOODS: I do not know whether the same fireman was employed during the two periods or what changes in the firing staff occurred. That certainly opens a liability to error in the test.

THE PRESIDENT: Mr. DeVoy, may we hear from you?

MR. J. F. DEVOY (M. E. C. M. & St. P. Ry.): Mr. Chairman, I wish to thank you for calling on me, but I did not intend to say anything. I have not looked into the paper until tonight, and have not had more than about five or ten minutes on it altogether. I will, however, reiterate the statement I have made several times before this Club in about these words. I said at the second to the last meeting, I believe, that it was up to the mechanical department largely to prevent engine failures. I made the statement that I thought fully 50 per cent was due to bad boiler design, and it is evident that that is true. It is also evident from what the chairman has stated that while the treatment of water is carried on perhaps to a greater extent on the Northwestern Railroad than on any other road, that they do still have failures from scale. I want to make a point of that and also a few others. It is also true that according to the statements tonight that with a water purifying apparatus 22 per cent can be saved. It is also true from a statement of the General Foreman of the boiler shop of the Northwestern Road that there is something the matter with the design; that perhaps the spacing of flues has something to do with it. It becomes evident from the Wabash Railroad that perhaps the blow-off cocks have something to do with it and, gentlemen, I say to you tonight that it is up to the Mechanical Department, and that 50 per cent of the boiler failures are due to bad design, that can be taken care of by changes that will materially benefit conditions. I say to you that I have looked into the matter of the boiler failures more than any other one thing. The time has come now and the author of this paper should, among others, be highly complimented on taking the matter up. To my knowledge it was first strongly taken up by Mr. M. E. Wells in one of the best papers on boilers that was ever written, in my humble opinion. Prof. Goss went farther, the University of Illinois now comes along with a paper that is grand in its way, and it is only to be hoped that somebody will furnish the necessary revenue to continue the investigations. My opinion goes back to the fact that 50 per cent of the whole trouble can be taken care of by the Mechanical Department.

One thought that I cannot reconcile in my mind is, that those boilers under the same identical condition, but different construction, under identically the same steam pressure, the same water, the

same treatment of the water, will vary as much as 75 per cent. Is that due altogether to the formation of scale, and what are we going to do to prevent it? I say to you that for certain conditions I am still convinced that a different type of boiler, different flue spacings and a different arrangement of blow-off cocks are necessary to take care of the whole matter. I do not believe that anywhere near the attention has been given to boiler designs that should be. I am ready to take off my hat to the chemical department of any railroad and say they have done a great deal, but it still remains a fact, that they are still having some trouble, and as I say, the better chemists of the lot are having just as much trouble as those that do not know quite so much about it.

Now, what are we going to do with that? We have got to go right back to the mechanical means and soften up that sludge in such a manner that we can carry it away with the best means available under different conditions. I believe that any chemist will agree with me that different conditions require different treatment and I am surprised that some of the different treatments are not spoken of more, for instance, the boiling of water, what the difference in cost has been, whether the taking off of the nine boiler makers was a good thing and whether that has been offset in the installation of proper apparatus to take care of it and what the treatment per gallon has cost. Has it paid to do that? After all it resolves itself into this same old question, do the different treatments and methods of handling the water pay for themselves in the different localities and are we right in installing them? And I wish again to make this statement, that while the chemical department has done its part, and should by all means continue, I say, that you will never get the results desired until the mechanical department has done its part.

Mr. Davidson: For the benefit of the last speaker, and also for the information of any others who may be interested, I wish to say the North-Western Line comprises over 9,000 miles of railway, and that we have thirty-seven water softening plants. In locating these plants we have had in mind volume of traffic as well as the character of the water. We are building additional plants every year, but, of course, have not been able during the four years since we commenced to equip but a small portion of the lines. The samples of scale that I have shown were not obtained from the portion of the road where we have water softening plants, but were obtained from a portion where we have recently gone over the ground and decided to locate several plants during the coming season, after which time we are quite sure that we will not be able to obtain any more such samples from this particular locality.

Mr. DeVoy: I do not want to be understood now as saying anything against the chemical department. The chemical depart-

ment is all right, but I would like to know how much it costs and if you treat water in one section of the country in one way what will you do in the other? How are you going to get at it, say in North Dakota, and get the men to treat the water without getting a track man to run the water treating plant. So, gentlemen, I say again, that 50 per cent of boiler failures are due to the design of the boilers.

THE PRESIDENT: I take it on your road, with the excellent design that you have inaugurated in your new power, that you have no failures whatever.

MR. DEVOY: I do so say, and I wish Mr. Peck were here, because the Chairman and Mr. Peck went for me the second or third last meeting; I stated there that all the failures were due to boiler design and now we have none.

MR. W. E. SYMONS: This is a very interesting paper, Mr. Chairman and we are very fortunate in having so thorough an analysis of the subject presented by Prof. Schmidt, who has the facilities to make tests that very few of the railway companies have.

Summing up the entire subject, however, or viewing it from its proper standpoint, involves so many different branches or features that it would be impossible to attempt to treat or refer to all of them, even if one were able or felt capable of doing so.

In the matter of waters, however, from rivers or other places giving different results to different users, as mentioned by one of the previous speakers, some of my own personal experience has occurred to me in connection with the operation of a portion of a railroad in Mexico wherein engines with new flues would only last about sixty days. I have known of several instances of only thirty days' service, although that was a very unusual case and to the minds of many would not be credited as a fact. However, it was at a point near the seacoast, the water being what is termed brackish, very salty. In order to try to overcome the difficulty we went up some distance from the mouth of the river, locating the source of supply some seven or eight miles from the coast and found to our disappointment very little difference in the water. After expending considerable money we felt that we would be compelled to abandon the location or give up the effort to get good water, when on a thorough analysis of the conditions and on investigation we found that there were two layers or stratas of water in the river, the fresh water flowing down from the foot hills or mountains constituting the layer of fresh water on the top, while below and on the bed of the river was a layer of salt water. We therefore changed our suction from our pumping station, placing it on a float that was anchored near the center of the river so as to take our supply from a point about four inches from the surface, after which we had very little if any difficulty whatever. I have known of similar cases where a steamship was plying on a river and very little trouble was experienced with its boilers, while factories, mills and stationary

plants on the banks complained they were using the same water and got adverse results. The conditions comparatively were the same as above cited. The plants and industrial concerns on the banks of the river were not getting the same water as the boats, in fact, they were getting a quality of water that was heavily charged with scale forming material, while the water in the center of the channel was not of the same character.

I recall an experience on the Colorado River some years ago. I was chief engineer of a steamer running from Lower California up into the mouth of the Grand Canyon, and at certain periods of the year when the snow was melting in the mountains in Utah, causing a rise in the stream, called the Little Virgin River, the deposits or washings from the mountainside were of such a character that made it almost impossible to operate the steamship, and at times there were periods when we would be compelled to abandon our efforts to go up where there was a heavy current requiring the engine to work very strongly, for a week or ten days, until the entire flow from this particular river had ceased. The mixture of these waters resulted in a condition that had the effect of loosening the scale on the boilers formed by the other water and was, in effect, a boiler compound which would result in cleaning them out. This of course is a slight digression from the subject we have here this evening, but inasmuch as we have branched out into the general subject, I thought it not amiss to mention this one case.

In the very able paper we have this evening one or two points occurred to me that I would like to ask the author to touch upon in his closing remarks, one is whether any mechanical means were employed (in testing the tubes taken from the locomotive boiler referred to), to agitate the water during the period of the test so as to produce conditions similar to those under which a locomotive would be in service. Also, if the locomotive tested was standing still on a track or pit, or whether it was in any sense in motion.

There is quite a diversity of opinion I may say—I will correct that, however, and in its stead say that the thought or belief is almost universal and unquestionably correct of scale forming on tubes being a non-conductor of heat and resulting either in a loss of fuel or necessitating more fuel to give out the same amount of work. There are some dissenting opinions, however, the vote not being entirely unanimous. There are some people who claim to be authority on the subject who say positively that scale formations on tubes and boiler plates increase the conductivity of the plate and I do not know of the claim ever having been completely disproven. It has been frequently and to my mind very properly challenged, but the conditions under which the tests were made, or the results obtained which warranted the negative statement or the minority report were possibly conditions that are not thoroughly understood.

I recall an instance of a steamship running on Lake Michigan wherein the engineer, somewhat of a scientific gentleman, had data to show that towards fall, toward the close of the navigation season, when scale formation was largest on the flues, that the boiler steamed the freest. An analysis of the condition, however, proved that in the spring while he was using wood for fuel, commonly termed slabs from the sawmills, they were green, and in the fall he had dry ones and of course the boiler steamed freer, and he had reached the conclusion that his boiler steamed freer with its coating of scale than it did without.

I would like with the permission of the author and the chair to add a few quotations on conductivity of metals. One of our principal authorities on transmission of heat is Fourier, a French author, whose works thereon I would not assume to criticise. From Prof. Alexander Freeman's translations of Fourier's "Analytical Theory of Heat," I quote the following:

The coefficient of penetrability and permeability represented by the symbols H & K as used by Fourier, are the results of experiments conducted by Fourier in measuring heat transmission through a cast iron ring, or a sphere. Sir Alexander Freeman, the translator, in a foot-note mentions, that one of these is *subject* to *"sensible variations,"* that the other is *"most variable,"* and that on the subject, no series of experiments suitable to determine with what possibility the conduction of heat changes with temperature and pressure has been made.

In reference to the minority report, or those that claim that under certain conditions scale formation adds to the conductivity of boiler material, and, is, therefore, beneficial to, or increases the boiler's steam making capacity. I would refer to one of the recent authorities on steam boilers, transmission of heat, and the effects of incrustation or boiler scale; he adds his testimony to that of a long line of precedents, or authorities on the subject of heat transmission, conductivity of metals etc., of which there are about 40 from and including Sir Isaac Newton in 1690 down to the present period. In the advanced sheets of Professor Rowan's work however, wherein he quotes Dr. Rodgers of Madison, Indiana, U. S. A., as authority on 1/16 inch of incrustations causing 15 per cent loss in fuel and ¼ of an inch 60 per cent. The *London Engineer,* which is a recognized authority on all such matters challenges the statement with the following remark *"That it has been clearly shown that a thin scale 'increased'* the steaming power of boilers because scale emitted heat *more freely* than the surface of *iron* when in contact with water;" and the author is farther asked if in a re-print of his work, he will not more fully qualify on this point whether he still holds Doctor Rodger's reasoning to be sound or not.

In Wilson's work on steam boilers, page 165, it is claimd a scale

1/8 of an inch thick causes a loss of 20 per cent, 1/4 of an inch 60 per cent and 1/2 of an inch 150 per cent, while *another* authority claims that a layer or incrustation of scale favors transmission of heat up to a certain point where conditions remain neutral, and beyond which it will retard transmission.

Thurston's views are very clear as to boiler incrustations causing loss of fuel; there are many other factors, however, having a direct bearing on the steaming capacity of boilers brought out by this well known authority, the principal of which is in relation to a boiler having proper circulation; "that the efficiency of a steam boiler is dependent upon the efficiency of its circulation, as well as upon the extent of its conductivity and heating surfaces."

It is claimed on good authority that boiler plates are capable of receiving about 12 times more heat than is ordinarily transmitted when in contact with water. It might, therefore, be reasonable to assume, that a slight scale formation of a *certain character* might be more conductive to the giving off, or transmission of heat units, which the plate receives from the fuel, than the surface of the plate is capable of doing when in *direct contact* with a body of water. If this hypothesis should be found by experiment or otherwise, to be founded upon facts, it might afford an explanation, or solution of the conditions under which certain authorities have observed that a scale formation is beneficial to, and increases the steaming qualities of a boiler.

In such future series of tests, as may be conducted by the University of Illinois, and which I anticipate will be conducted, it might not be amiss if these points could be remembered, and if possible determine as to the probability of their existence in locomotive operation. I am also led to believe, that a test of a locomotive boiler while standing still would not give the same results as one in motion where the rolling and other vibratory motions contributed to the boiler would have the effect of keeping the water in constant circulation; frequently the movement is almost what might be termed violent; added to this, is the circulation due to the action of the injector, which would have a similar effect to the use of brushes, or mechanical means employed by Professor Stanton of the University College of Liverpool, wherein he found it necessary to employ mechanical means, in order to remove the body or layer of water, which if left in a quiescent mass would retard transmission or conductivity.

The question as to whether boiler scale is injurious or as to whether it presents faulty construction of boilers, or not I think is pretty well understood by all, that a scale is injurious and that it results in a loss of fuel: We find a proof of this in the use of compound engines, wherein there was a lower rate of combustion due to the fact, that a less number of lbs. of coal were necessary, in

order to generate the amount of steam to move the train; this results in a less amount of water being evaporated, and of course, less scale formation: The repairs to the boilers were less, also by the additional fact, that the exhaust of a compound engine is easier on fire and consequently easier on the boiler.

There are other kinds of locomotives wherein the steam distribution effect on the exhaust, etc., gives similar results, and I simply offer these suggestions, so that if they are considered worthy of attention, that in future experiments they might be considered with a view of the results obtained, comparing as nearly as possible to actual service conditions, as can be brought about in laboratory work.

THE PRESIDENT: I think the scale will have some friends yet before we get through. We have not heard anybody say anything in favor of scale until Mr. Symons spoke. Now, I want to say something in favor of scale. Is it not a fact that if we keep our flues so clean that no scale will be deposited on them, that we will have trouble in other directions? I have in mind frequent cases where certain waters have been thrown upon the flues that did not form scale, but instead they have caused the flues to pit, and of two evils I would choose the least and have a little scale. I would like to ask if any of the members present have had any experience with pitted flues, not particularly where these treating plants are in operation, because we have more pitted flues where we do not have purified water than we do elsewhere, but whether anybody can throw any light on the subject of the pitting of flues where the flues are not coated with scale?

MR. IRA C. HUBBELL: There is one point to which I wish to refer that has not been developed in these remarks. In reading the paper I was particularly impressed in its favor by the modesty of its statements; it acknowledges the pros and cons, it seems from its beginning to its concluions, and there is nothing further that I could add, as I would simply repeat what has already been stated.

MR. GEO. R. CARR (Dearborn Drug & Chemical Works): From the standpoint of practical railroad experience I can give nothing on the subject; however, during the past several years I have had considerable to do with the treatment of waters from a chemical point of view. On this question that you have just asked, Mr. President, regarding the pitting of boilers and boiler tubes, would say that such action is dependent upon the chemical constituents of the water. If there is no sulphate or carbonate of lime or magnesia in the water, but if the water contains alkaline salts, such as chloride of sodium or potassium, it will cause pitting. It is seldom, I think, that you find flues that are pitted where there is not a certain per cent of scale present; where this condition does exist, however, the waters, of

course, do not contain any scaling salts, but the alkaline salts predominate.

MR. WALLACE: Since the matter of design has been mentioned, I would like to say that we have in mind the fact that improvements can be made in design and to that end we are working. In "Locomotive Design" our work is so organized and governed that research work and original ideas are fostered, thus developing the best possible design in the light of today. We receive a great deal of inspiration from the "Master Mechanics' Proceedings," which is our guide, and also from the many able papers presented before various railway clubs. Be it further said that all known and suggested means of escaping the formation of scale and other boiler troubles are thoroughly studied to the end that our boilers may be as free from criticism as it is possible to make them in the light of the present time.

MR. WOODS: Just a word in reference to pitting waters. I have had some experience with waters of low alkilinity that pit and do not scale, and among the constituents in the waters are magnesium chloride; also magnesium sulphate and magnesium carbonate in the presence of sodium chloride; those are among the constituents that pit badly and do not scale.

THE PRESIDENT: Is there any further discussion on this paper? If not, we will ask Prof. Schmidt to close it.

MR. W. O. MOODY (M. E. Ill. Central R. R.) Communicated: While the subject was primarily upon radiation as affected by scale upon the metal composing the heating surface, the discussion naturally followed the lines of feed water purification.

This road has treating plants on bad water divisions, and on others uses soda ash and a mechanical device which injects an oil into the boiler, all three types giving good satisfaction under the conditions where they are in operation.

We average about one pound soda ash to 1,000 gallons. In our tanks of 7,000 gallons capacity, we use one quart of soda ash on one of our northern Illinois divisions and one pint when the tank is from one-third to one-half full; the instructions being to keep the water in the glass milky white, while to prevent foaming a surface blow-off is placed in the back head. The benefits of this treatment are neutralized by not using the blow-off cock sufficiently in order to properly clear the boiler of sediment and scale thrown down by the soda ash. The blow-off is used before the engine leaves for its train and when over the cinder pit at the conclusion of its run.

The soda ash prevents the formation of scale with these waters and we have in evidence a stationary plant which has been in service 18 months and has but 1/32 inch thickness of scale.

Mississippi River water during the flood season is especially bad for boilers, more particularly near the mouth where it is influenced

by the discharge of other rivers. We have also found that water which has been considered as good was rendered unfit for boiler purposes by the sewage discharged from recently erected industrial concerns near the mouth of the intake.

I have in mind a switch engine working in a bad water district where the tubes required attention every 24 hours but the first use of soda ash enabled the engine to run for a period of 30 days before the services of a boilermaker were required.

PROFESSOR SCHMIDT: Before replying to some of the more specific questions and remarks I should like to emphasize the two main points of the paper to meet some of the general discussion.

The main object was to obtain figures concerning the loss due to scale in individual cases. Possibly, on account of differences in water circulation, these results might have been different had road conditions been more exactly realized. If this is so, it is probable that the losses shown might have been slightly greater.

As concerns the relation of this loss to thickness and structure, it is obvious that both of these items are involved in the results. Had the apparent effect of structure been anticipated, steps would have been taken to eliminate differences in the scale structure in the tubes tested.

The loss in conductivity does undoubtedly increase with the thickness of the scale. Of two tubes covered with scale identical in structure, but of different thickness, the tube with the thicker scale will have the lower conductivity.

It should be borne in mind that the results of these tests, as concerns loss due to scale, are comparative. Possibly a greater range of water temperature or more rapid rate of conduction as well as a more active circulation of water around the tubes would have changed somewhat the comparative results. It is difficult to estimate the effect of such changes; but it seems probable that they would not have greatly changed the percentage losses.

It has been pointed out that the maximum thickness of scale dealt with in these experiments is small, the implication being that they are below the average. We had suppossed that they fairly represented the general condition of the tubes of locomotives in service. They were collected from various roads in this part of the country without stipulation as to scale thickness and were all removed from locomotives which had been shopped for general repairs and boiler cleaning.

I should like to call attention to the necessity for exercising the greatest care in such experiments. It is not easy to make comparative tests of either locomotive or stationary boilers in which all variables except the presence or absence of scale are eliminated. Tests made with other ends in view are very apt to present such uncertainties as to preclude the possibility of making reliable deductions concerning the effect of scale.

It is our intention to continue experimental work along these lines. In future experiments we shall attempt to eliminate the double variable (thickness and structure) with a view to obtaining more specific information concerning the relation between the loss due to scale and its thickness. We hope to be able in some measure to realize Mr. Barnum's wish for a formula expressing this relation.

Mr. Davidson evidently feels that the hard scale is worse than soft scale—that it will result in greater loss. I must confess that it is difficult for me not to take the same view of this matter. We must admit, however, that this assumption rests on meagre information. His remarks give me the opportunity to emphasize, as I wish to do, that the view stated in the last footnote in the paper, namely, that soft porous scale may be found to cause the greater loss, is a mere hypothesis.

Some defense for such an opinion may be found in the experimental work of Fourier and others on the conductivity of metals. In these experiments the heat transmitted was measured by its absorption in water. Preliminary experiments indicated practically no difference in conductivity in different metal plates or in different thicknesses of the same metal. The difficulty was found to lie in the fact that, in these experiments, a film of water clung to the surface of the plate. This film had a conductivity relatively so much lower than that of the metal plate that its effect practically hid the differences due to the metals and to their thicknesses. When this film of water was kept removed from the surfaces in later experiments the latter differences in conductivity were easily observed.

It seems probable that a soft and porous scale would hold within itself such a film of non-conducting water or vapor and might therefore prove worse than a layer of hard smooth scale of like thickness. Of course nothing but experimental data can settle such a question.

President Bentley has made, it seems to me, an important point in calling attention to the greater relative importance of the effect of scale upon the cost of maintenance of locomotives and the loss due to their withdrawal from service. Both these items, I think, are much more serious than the mere fuel loss which we are discussing.

In response to Mr. Symons I wish to say that, in the locomotive test referred to, the engine was not in motion; but was standing over a pit in the round-house. No attempt was made to agitate the water in the boiler or to produce more circulation than naturally resulted from the action of the fire and from the operation of the injector. I suppose, Mr. Symons, that you had in mind the non-conducting effect of the film of water or vapor which might adhere to the tube under such circumstances.

I am glad that you have referred to Fouriers work and quoted from him. Any one expecting to undertake this sort of work ought certainly to familiarize himself with these and similar experiments.

Mr. Symons: The thought came to me in connection with Prof. Stanton's work, University College, Liverpool, where in making tests of conductivity of plates and transmission of heat they found it necessary to employ mechanical means to dispose of the layer or film of water or gas that would lie next to the plate and as you have well said, was a non-conductor of heat and which I assume was and is disturbed in locomotives in service by virtue of the locomotives' rolling and tossing from side to side on track that is not just smooth, and pitching, and also from action of water due to circulation.

Professor Schmidt: I have no doubt, Mr. Symons, that such effect would take place if the tests were made under such conditions. I think your point is well taken that in tests made under service conditions this layer of water or vapor might perhaps be removed in a measure by the agitation of the water due to the motion of the engine. If this effect does take place the result would be, I think, to make the loss due to scale greater than shown in these experiments. It is extremely difficult, however, to make such tests under service conditions and eliminate all other uncertainties as we have tried to do in these experiments.

Mr. Hubbell: I move a vote of thanks to the Professor for the very instructive and interesting paper of the evening. Seconded.

The President: It is moved and seconded that a vote of thanks be given Prof. Schmidt for the very interesting paper that he has read to us to-night. All in favor, say aye.

Motion carried.

The President: Professor, we are deeply indebted to you for a very interesting and agreeable evening and I wish to thank you personally as President of this Club for the entertainment and instruction you have given us.

ADJOURNED.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium on Tuesday evening, April 16, 1907, Vice President C. A. Seley in the chair. The meeting was called to order by the chairman at 8 P. M.

Among those present the following registered:

Akerlind, G. A.
Allison, W. L.
Ames, C. F.
Arlein, E. J.
Axtell, Ford.
Ayers, A. R.
Ball, R. L.
Barnum, M. K.
Beattys, W. H., Jr.
Beecham, W. E.
Belknap, R, E.
Benedict, B. W.
Blatchford, C.
Boedefeld, F. J.
Bott, A. G.
Bryant, G. H.
Callahan, J. P.
Cardwell, J. R.
Carney, J. A.
Chisholm, J. E.
Cram, T. B.
Curtis, J. J.
Dangel, W. H.
DeRemer, W. L.
DeVoy, J. F.
Dodd, T. L.
Dolly, J. M.
Downer, E. M.
Drennan, W. M.
Dudley, R. C.
Eayrs, T. C.
Elliott, C. F.
Endsley, L. E.
Estrup, H. H.
Farmer, G. W.
Farrelly, A. J.
Fenn, F. D.
Flavin, J. T.
Fogg, J. W.
Forsyth, Wm.
Gilman, C. R.
Goodnow, T. H.
Goodwin, G. S.
Gowing, J. P.
Hammond, W. S., Jr.
Haig, M. H.
E. Hacking.
Harkness, F. L.
Hayes, R. F.
Haynes, J. R.
Hennessey, J. J.
Hill, C. P.
Hincher, W. W.
Hodgkins, E. W.
Hooper, W. H.
Hopkins, G. H.
Hopkins, W. R.
Hull, G. A.
Hunter, P.
Isbester, G. C.
Jansen, E.
Jeffries, B. H.
Jennings, D. F.
Jett, E. E.
Johnson, W. O.
Kadish, R. B.
Keeler, Sanford.
Kelley, H. D.
Lancaster, J. K.
LaRue, H.
Layng, J. F.
Lewis, J. H.
Lickey, T. G.
Little, J. C.
Lucore, F. M.
Manchester, A. E.
McAlpine, A. R.
McCarthy, M. J.
McGarry, A
McLelland, H. B.
McNulty, M. B.
Medland, W. C.
Meeder, W. R.
Midgley, S. W.
Miller, J. S.
Monroe, M. S.
Moskowitz, M.
Mullen, F. T.
Munger, E. T.
Naylor, C. R.
Neff, J. P.
Orne, C. S.
Osmer, J. E.
Ott, O. W.
Park, H. S.
Parker, P.

Passmore, H. E.
Peck, P. H.
Phillips, L. R.
Richardson, G. A.
Robb, J. M.
Rosser, W. W.
Royal, Geo.
Russell, M. F.
Schragg, C. F.
Seley, C. A.
Seymour, J. B.
Sharp, W. E.
Shields, H. S.
Shumate, F. D.
Sipp, B. F.
Slaughter, H. W.
Smith, H. E.
Stewart, H. A.
Stimson, O. M.
Symington, E. H.
Symonds, W. E.
Taft, R. C.
Tawse, W. G.
Taylor, C. H.
Taylor, C. O.
Taylor, J. W.
Taylor, W. H.
Thomas, C. W.
Thompson, E. B.
Thompson, J. R.
Tinker, J. H.
Towsley, C. A.
Tratman, E. E. R.
Walter, Chas.
Walter, W. B.
Willis, F. D.
Wright, Wm.
Younglove, J. C.

THE CHAIRMAN: First in order is the approval of the minutes of the last meeting. These have been printed and distributed, unless objection is made, they will be approved as issued. They are approved.

The Secretary has the usual report.

THE SECRETARY: Mr. Chairman, I have the following membership report:

Membership March 1907		1,365
Dropped		
Resigned	4	
Mail returned	2	
Non-payment of dues	10	
		16
		1,349
New members approved by Board of Directors		37
		1,386

DROPPED.

J. E. Coggshall, Foreman C. M. & St. P. Ry., Davenport, Ia., Resigned.
R. S. Emmett, R. M., C. B. & Q. Ry., Chicago, Resigned.
E. L. Van Dresser, Rail Joint Co., St Paul, Minn., Resigned.
C. C. Borton, Southern Pac. Co., Oakland, Calif., Resigned.
W. C. Law, Foreman L. S. & M. S. Ry., Elkhart, Ind., Mail returned.
W. L Hunder, Stk Pere Marquette R. R., Grand Rapids, Mich., Mail returned.
J. W. Leonard, G. S. Can. Pacific Ry., Winnipeg, Man., Non-payment of dues.
J. B. Latimer, R. M., C. B. & Q. Ry., Chicago, Non-payment of dues.
J. E. Langston, Piece Work Insp. C. B. & Q. Ry., Havelock, Neb., Non-payment of dues.
C. K. Bowles, M. M. Farmville & Powhatan R. R., Chester, Va., Non-payment of dues.
D. P. Kellogg, M. M. Southern Pac. Co., Oakland, Calif., Non-payment of dues.
J. M. Brown, Mgr. F. H. Lovell & Co., Chicago, Ill., Non-payment of dues.
W. E. Bryant, Detroit Lubricator Co., Detroit, Mich., Non-payment of dues.
R. W. Colville, M. M., C. B. & Q. Ry., Galesburg, Ill., Non-payment of dues.
A. P. Goodwell, R. H. F., A. T. & S. F. Ry., Topeka, Kan., Non-payment of dues.
J. B. Galivan, R. F. E., A. T. & S. F. Ry., San Bernardino, Calif., Non-payment of dues.

F. E. Wolf, Boiler Inspector C. B. & Q. Ry., Galesburg, Ill.	M. H. Wickhorst
Jas. N. Hatch, Struct. Engr. Sargent & Lundy, Chicago, Ill.	J. W. Taylor
A. J. McKillop, M. M. Ill. Central R. R., Freeport, Ill....	W. O. Moody
R. C. Dudley, Chgo. & Cleve. Car Roofing Co., Chicago, Ill.	J. J. McCarthy
W. H. Riley, Gen'l Foreman Ill. Cent. R. R., Chicago, Ill..	T. F. Barton
M. J. Feron, Supt. Trains & Stations, Metropolitan L., Chicago, Ill.	E. T. Munger
C. H. Taylor, Mach. Shop Foreman Armour Car Lines, Chicago, Ill.	W. E. Sharp
F. G. Phegley, American Engr. Specialty Co., Chicago.....	W. D. Pickels
Irby Williams, Engr. Dept., C. R. I. & P. Ry., Chicago.....	G. J. Slibeck
Wm. A. Murray, Asst. Engr. N. Y. C. & H. R. R. R., N. Y.	D. L. Somerville
C. R. Naylor, T. H Symington Co., Chicago..............	W. L. Allison
Edgar I. Wenger, Asso. Ry. Eng. Univ. of Ill., Urbana, Ill.	E. C. Schmidt
E. L. Palmer, H. B. Dodge & Co., Chicago...............	A. L. Holtzman
Martin Norell, Draftsman Nat'l Dump Car Co., Chicago...	G. A. Akerlind
John H. Mallon, Train Master, S. S. E. R. R., Chicago....	J. M. Feldhake
Robt. F. Carr, V. P. & G. M. Dearborn Drug & Chem. Wks., Chicago	G. R. Carr
Donald C. Barbee, Pres. Standard Metal Mfg. Co., Chicago.	J. J. Cummings
A. Sorg, Prest. A. Sorg, Jr. Co., Chicago...............	W. L. Sturgis
W. P. Chrysler, M. M. Chgo. Great Western Ry., Oelwein, Ia.	J. E. Chisholm
W. B. Walter, Prest. W. B. Walter Co., Chicago..........	W. E. Symons
Carter Blatchford, Spencer Otis Co., Chicago............	G. A. Akerlind
George Fuller, Railway Supplies, Chicago................	M. K. Barnum
Geo. A. Hull, Draftsman C. R. I. & P. Ry., Chicago.......	C. A. Seley
M. B. McNulty, Salesman, Pratt & Lambert Co., Chicago.	J. P. Gowing
W. E. Beecham, Car Acct. C. M. & St. P. Ry., Chicago....	A. E. Manchester
H. W. Ensign, Locomotive Engineer C. G. W. Ry., Chicago.	J. M. Robb
W. R. MacKenzie, Locomotive Engr. C. G. W. Ry., Chicago.	J. M. Robb
F. M. Lucore, Asst. Car Acct., C. B. & Q. Ry., Chicago..	R. F. Nickson
H. E. Warner, Piece Work Insp. L. S. & M. S. Ry., Elkhart, Ind.	A. R. Ayers
W. W. Rosser, T. H. Symington Co., Chicago............	J. W. Taylor
F. T. Mullen, Contracting Frt. Agt., A. T. & S. F. Ry., Chicago	R. B. Kadish
J. F. Green, Gen'l Foreman Wabash Ry., Chicago.........	B. H. Jeffries
B. I. Budd, Pur. Agt. Metropolitan W. S. Elevated Ry., Chicago	E. T. Munger
J. N. Langan, Chgo. Ind. & So. Ry., Kankakee, Ill........	J. T. Flavin
E. F. Berger, Midvale Steel Co., Chicago.................	A. E. Goodhue.
A. B. Summers, Engineer C. B. & Q. Ry., Centerville, Ia..	G. P. Wick
J. A. Jackson, Gen'l Foreman Chgo Repr. Car Co., Chicago.	D. L. Phipps

The Chairman: We have this evening for discussion two subjects, one, the "Report of Committee on Proposed Revision of the Rules of Interchange," and a paper on "Electric Train Lighting."

Prior to taking up the discussion of the Rules of Interchange, I wish to advise that we have with us this evening Mr. W. E. Beecham, Car Accountant of the Chicago, Milwaukee & St. Paul Railway, who has a matter of interest to the roads particularly in this vicinity which he would like to bring up. It is in relation to the delays in movements of empty cars at terminals. As Mr. Beecham is not a member of the Club, it will be necessary that a

motion be made that he be heard, and I would strongly recommend that we hear Mr. Beecham and encourage the transportation people to come forward and take part in the work of this Club. We are not a purely mechanical Club; we want to represent all the departments of railroading, and if it is your pleasure, I would like to have a motion made that we hear Mr. Beecham.

MR. P. H. PECK (C. & W. I. R. R.): Mr Chairman, I move that he be allowed the privilege of the floor.

Motion was seconded by Mr. Manchester.

THE CHAIRMAN: Unless objection is made, Mr. Beecham will be granted the privilege of the meeting. I have the pleasure of introducing Mr. Beecham.

DELAY IN MOVEMENT OF EMPTY CARS AT TERMINALS.

Mr. W. E. Beecham, Car Acct., C., M. & St. P. Ry.

For some time past I have been looking for an opportunity to attract the attention of the railroads centering in Chicago to the manner in which empty foreign cars are sometimes, so to speak, thrown in the air between them, and I am inclined to the belief that this is the right time and place to begin a crusade of that kind, and I will be glad if there is a representative present in this assembly from the Car and Operating departments of every railroad centering in Chicago to hear what I have to say on this subject and, if I should succeed in arousing so strong a sentiment against this practice that its complete and final suppression follows as the logical result of the discussion which I hope to provoke on this occasion, I shall consider myself amply repaid for the effort.

At the outset I wish most emphatically to record my belief that the practice referred to has no warrant for existence and that, in my judgment, it is not only inimical to the interests of every railroad centering in Chicago, but it is besides a positive injustice to car owners.

I shall make no attempt to fix the responsibility for this state of affairs in the interchange of cars between the roads centering here, because that would be useless and perhaps impossible, and, besides, it would do no good. What is needed is a remedy for the difficulty and if one is found it must be obtained through the cooperation of all the lines in interest, and, in order to place the matter before you in its proper light, it will be necessary to furnish some evidence of the existence of the practice to which I allude.

In doing this, direct reference must necessarily be made to the railroads directly involved, but that does not imply a desire on my part to make invidious comment likely to provoke an accrimonious discussion. Direct reference is only made to enable me to place the question before the assembly in an intelligent manner and to strengthen my argument against the continuance of a practice which

I feel assured you will all say has none of the elements of a business proposition and is therefore not good railroading.

If the Master Car Builder's Rules of interchange and the rules adopted by the Car Foreman's Association of Chicago were observed, such movements as are here specifically cited would never occur, because those rules are fully qualified to provide for all cases arising from disagreements of inspectors over the condition of cars, and if the rules of the General Superintendent's Association of Chicago were observed, they would be infrequent, because those rules are sufficient to insure proper handling of cars under most circumstances.

It is apparent then that we don't need any more rules or agreements to meet the situation and that a failure to observe the rules and agreements now in effect is the cause of the trouble. I am satisfied that very few railroad officials know to what an alarming extent the mishandling of cars in a large terminal is carried, for the reason that it is impossible to compile comprehensive statistics necessary to make a showing. It goes on from day to day, year in and out, but I am of the opinion if it were practicable to show all the unnecessary movements which empty cars make in a large terminal like Chicago and the amount of time, money and energy wasted in consequence, it would astonish the most skeptical. Many causes combine in forcing empty cars to make a great many useless and unnecessary movements in all large terminals, but for my purpose it will only be necessary to mention a few of them.

Errors on the part of yard forces cause many cars, loaded and empty, to go wrong, and I presume we shall never be able to entirely overcome that, but such errors should be reduced to an insignificant minimum and so they will be if due care and diligence is exercised in handling cars. By carefully training and educating employes to take a personal interest in the economical conduct of affairs, we can gradually lead them to a proper understanding of the importance of doing things well and, so far as possible, avoiding false movements in handling cars. They should always be sure to get the proper destination of a car and then see that it is properly started on its way.

Switchmen should be urged to report in every case where they have been required to handle cars unnecessarily, in order that steps may be taken to avoid re-occurrence.

Disagreements and disputes between inspectors as to responsibility for defects existing in cars cause them to make more unnecessary movements empty than any other known cause and my experience is that investigations are generally barren of results. Why this should be I am not in position to say; I only know that it is so, and so far as I can see there is no excuse for it. At the same time, I admit I am not qualified, by practical experience, to judge of the merits of a case involving mechanical points and, for the

same reason, it is difficult for me to present the question to you in all its various aspects. I could not determine the mechanical merits of any case, even if I had the exact condition of all the cars I shall refer to, because I am not a car builder, but there is one thing I do feel pretty sure about and that is that the mechanical departments are largely at fault for conditions tending to wastefulness and contributing to bad work in a terminal where there is neither room nor time to spare, and it is to that department, without bias of any kind, that I desire most particularly at this time to address myself.

If it were not customary, and necessary as well, to interchange cars in bad order, it would be easy to find a remedy for the difficulty referred to by making an agreement that delivering lines must invariably see to it that all cars offered in interchange shall be put in good order beforehand, but such a restriction would hamper and retard the movement of traffic in a most vexatious manner, moreover, it would nullify, if not entirely destroy, one of the wisest provisions of Master Car Builder's rules. A great many cars cannot be repaired under load, and, as transfers fall on receiving lines in Chicago, such cars are delivered to connections, shipments transferred and cars returned, and here is where the trouble begins.

It frequently happens that existing defects are augmented by the switching and when such a car is returned to the delivering line it is rejected by the inspector and, without any attempt being made to adjust matters the car is immediately sent back; then commences the shuttle-cock process and before the case of such a car is settled it may make many movements between two railroads, because one does not want it and the other won't have it—all the while piling up trackage and per diem for the juggling roads to pay and depriving the owner of the use of his car besides.

The interchange of cars between the St. Paul and most of its connections in this terminal is through the Belt lines. The charge for moving an empty car is a dollar one way and, in addition, a reclaim of twenty-five cents is allowed for the intermediate move, making the charge to the delivering line $1.25 to $2.50 for the round trip. I have a number of cars that have made unnecessary movements between the St. Paul company and its connections, and if you will follow me I will endeavor to show you what these unnecessary movements entail in the way of expense.

D. L. & W. car 23060 made four round trips empty between the St. Paul and the N. Y. C. & St. L. roads between February 17, and April 15, at an expense for trackage and per diem of $40.00 before its case was finally settled. In this case candor compels me to admit that the evidence is very much against our own people, but that is not going to deter me from making an open confession and stating the facts. This car was delivered to us under load and in good order, it is claimed, and we returned it with two center sills

and one inner sill broken, making a combination of defects. The N. Y., C. & St. L. refused to receive it and our Chief Inspector went to Stony Island and saw Mr. James, Master Mechanic, N. Y., C. & St. L. Ry., about the car. The next day a letter was received from Mr. James saying he would accept the car on the following conditions, namely, that the car shall carry home route cards and that the two center sills be planked in proper shape so that the car will be safe to handle in trains to Buffalo. Also, that defects on car must be fully covered by our Master Car Builder's defect card. Admitting, for the sake of argument, our defenseless position in sending an empty car to a connecting line in such a condition, let me ask first, why should a delivering line be called upon for a home route card for a car that was entitled to return via the Nickle Plate to the owner, one of its direct connections, and second, why did the Nickle Plate not repair the car, load it to Buffalo, or in that direction, and call upon us for defect cards covering our responsibility, according to Rule 8 of the Car Foreman's Code?

These questions are not asked with a view of letting the St. Paul down as easily as possible, or for the purpose of showing that the Nickle Plate is to blame. Here is a 60 M capacity box car out of service for sixty days while two roads juggle it between them empty and pay $40 for the privilege.

G. S. & F. Ventilated Fruit car 2363 was received from the I. C. via the Chicago Belt February 23, loaded for Milwaukee, and when made empty it was returned to our Galewood yard where it arrived March 1st and on March 2nd it was returned to the I. C. via the Belt. This car also made four round trips via the Belt between the I. C. and our line and was last returned to us March 26, and is in our yard at this writing.

Per diem and trackage accumulated on this car to the amount of $32.50. This makes a total of $72.50 for three roads to pay for the privilege of juggling two empty foreign cars between them, which I think you will admit is equivalent to throwing so much money away.

These two instances are of themselves sufficient to fully illuminate the point I am trying to make and I am satisfied that it is only necessary to draw attention to this matter to fully impress upon the minds of all concerned the importance of taking immediate action to put a stop to such wastefulness.

I am not able to furnish much information in regard to the last mentioned car. Our Chief Inspector, Mr. William, went to see General Foreman Dare of the I. C. and he reported that Mr. Dare said the car was not rejected by his inspectors, although it was in bad order, but Superintendent of Transportation Keith, of the same road, wrote to me that it *was* rejected by his inspectors and he further stated that his company will not accept cars in bad order unless fully carded for defects. At the same time, Rule No. 8 of the Car Foreman's Association does not require that cars should be so carded. That rule reads as follows:

"It is understood that in the interchange of cars within the Chicago Switching District all parties to this agreement will accept as their own the record of the receiving line, so far as the condition of the car is concerned, and that M. C. B. Defect Cards will be furnished for such defects when proper request is made, when based on M. C. B. rules and this agreement."

The Master Car Builder's Rules provide that cars offered in interchange must be accepted if in safe and serviceable condition, the receiving line to be the judge in cases not provided for in Rules 3 to 56 inclusive and in the declaration of principles the Master Car Builder's Rules must positively affirm that "These rules make car owners responsible for, and therefore chargeable with, all repairs to their cars necessitated by ordinary wear and tear in fair service, so that defect cards will not be required for any defects thus arising."

One thing is made clear to my mind at least by this exhibit, which is that there is a wide difference of opinion among employes of the Car Department regarding the intent and purport of the M. C. B. Rules of interchange and the subsidiary rules of the Car Foreman's Association, otherwise empty cars would not make such movements as have been cited.

This may be due in great measure to the failure of those whose duty it is to properly instruct inspectors respecting their duties and in part to a mistaken idea that it is the duty of an inspector to get ahead of others by employing sharp practices if necessary. There is a cause for every effect and as we know what the effect is in this case, we ought to find the cause and a remedy for it.

Inasmuch as I have arraigned this practice and have no hesitation in saying that I cannot command language too strong in condemnation of it, I presume you will expect me to suggest a remedy, but I am not fully prepared to do that at this moment. However, I will make one or two suggestions:

When an empty car, foreign to your road and to the delivering line, is received in bad order, don't let your inspectors fire it back on the next transfer without calling the attention of the Chief Inspector to it and don't send it back then until you have notified the Chief Inspector of the delivering line of your intention to do so and given him the reasons for that course. Then see to it that all cards of very kind are stripped from the car and that your cards are put on both sides, plainly indicating that the car is being returned on account of being in bad order and, in addition, bill it to Mr. Blank, Chief Inspector of Blank Railroad, and show on billing defects which you object to. Take every legitimate means at hand to protect your company from imposition, but remember that the mutual interests of the railroads centering in a common terminal are entitled to great consideration at your hands and that all lines should work as one

for the common good, when they can do so without detriment to their own interests.

Try to impress upon the minds of the inspectors this important fact, namely, that every time you move a car it costs money which somebody must pay and that unnecessary movements must be avoided.

Every road in Chicago has a way of protecting itself if it finds other lines are acting unfairly in the matter of giving it empty cars in bad order. It can return a car and charge the delivering line one-half the regular rate, $2.50, and in addition to that, the reclaim for three days per diem and, in addition to that it can insist that Belt Line charges shall be assessed against the line at fault. So you see it is possible to make it expensive for any line guilty of unfairness.

Misunderstandings, mistakes and unintentional failures to observe ordinary care cause most of the troubles we complain of. These difficulties can all be met and successfully overcome if we all join hands together in well directed efforts to conserve the common good and with a view of taking some action to-night to bring about a result so much to be desired: I will offer a motion that the subject of this paper be referred to a committee of three, to be appointed by the Chair, to investigate and report its findings and make recommendations to the next meeting of this club.

Mr. Beecham: If the Chairman will permit, I will offer a motion.

The Chairman: We will accept your motion.

Mr. Beecham: I will offer a motion that the subject of this paper be referred to a committee of three to be appointed by the chair, to investigate and report its findings and make recommendations to the next meeting of this Club.

The Chairman: Inasmuch as we have had no advance copy of this paper, I think it will be highly advisable to defer discussion of it until the next meeting, and I had in mind the very motion which has been proposed by Mr. Beecham and believe that will be the best action to take.

Mr. H. LaRue (C., R. I. & P. Ry.): I would like to suggest that the number of the committee be made five, instead of three.

The Chairman: Will that be acceptable to Mr. Beecham?

Mr. Beecham: Yes.

The Chairman: Does that meet with a second?

Motion was seconded by Mr. Manchester and carried.

Mr. Peck: I would like to make one suggestion. As Mr. Beecham's paper refers altogether to the mechanical department, I would recommend that the Chair in appointing this committee of five, appoint two members from the operating department. The operating department causes a great many of the moves that Mr. Beecham complains of, therefore I would like to see that department represented on the committee.

The chairman subsequently appointed the following committee:
J. E. Buker, A. S. M., Illinois Central R. R
A. E. Manchester, S. M. P., C. M. & St. P. Ry.
C. W. Kouns, Supt. Trans. A. T. & S. F. Ry.
F. M. Luce, Aud. Car Accts., C. & N. W. Ry.
H. La Rue, M. C. B., C. R. I. & P. Ry.

MR. A. E. MANCHESTER (C., M. & St. P. Ry.): As Mr. Beecham was reading his paper, the thought occurred to me that this would be a pretty good place for the Car Accountants of Chicago to come and ventilate their views and tell us what their troubles are. Our Secretary has been looking for papers on good, live subjects, and I think that this will be a hint now to know where to go for some papers. There is a gentleman here from every road in Chicago who stands ready to propose the names of the Car Accountants of Chicago to become members of the Western Railway Club. (Applause.)

THE CHAIRMAN: We will now proceed to the consideration of the Report of the committee on Proposed Revision of the Rules of Interchange. There have been distributed around the hall copies of the present code, and also copies of the report which has been submitted by the committee, and there are copies on the table if anyone has not received a copy.

The first rule which it is proposed to revise is Rule No. 7, and I would ask if any member has anything to offer on any rule prior to Rule 7? If not, I will ask the Secretary to read the proposed revision of Rule 7.

THE SECRETARY: "Rule 7—Shelled out: Wheels with defective treads on account of pieces shelling out; if the spots are over 2½ inches, or are so numerous as to endanger the safety of the wheel under 80,000 lbs. capacity. 80,000 lbs. capacity and over, limit to be 2 inches."

THE CHAIRMAN: I would like to say in an individual capacity that this strikes me as not being constructed exactly as we would like to see it go into the rules. If before the words "80,000 capacity," you will interpolate the words, "cars of less than" I think that is what the committee is trying to say, but it does not say it very clearly. It would then read, "or are so numerous as to endanger the safety of the wheel under cars of less than 80,000 lbs. capacity." Is there any discussion on this rule? If not, a motion will be received to approve the recommendation of the committee. I hope the committee will not be so modest as not to get up and defend their own rules, or make motions.

On motion of Mr. Goodnow, the recommendation of the committee was adopted.

THE CHAIRMAN: Has any one a recommendation on Rule 8? Rule 9, Mr. Secretary.

THE SECRETARY: "Rule 9—Worn through chill: When the worn spot exceeds 2½ inches in length on wheels under 80,000

lbs. capacity, 2 inches on 80,000 lbs. or over. Care must be taken to distinguish this defect from flat spots caused by sliding wheels."

THE CHAIRMAN: This rule I think will bear grammatical correction. the same as Rule 7.

MR. GOODNOW: The proposed rules as they now read are practically the same as the M. C. B. rules; they make no mention of the cars, although we are willing to accept your suggestion.

THE CHAIRMAN: What I am criticising is this: "to endanger the safety of the wheel under 80,000 lbs. capacity," that does not mean very much; somebody might say that means under a car of 80,000 lbs. capacity, and then the next clause contradicts it, you leave it up in the air as to what you really mean. What I would like to see go in there, with the permission of the committe, would be to interpolate "cars of less than."

MR. GOODNOW: We accept your suggestion to change the phraseology of those rules, but practically the present rules are worded as they are now.

THE CHAIRMAN: There is no change in the body of the rule as it exists, only change in the phraseology. Is there any discussion? A motion is in order.

MR. GOODNOW: I move that we accept it.

The motion was seconded and carried.

THE CHAIRMAN: Has any member anything to offer on rules between 9 and 19? Rule 19.

THE SECRETARY: "Rule 19—Flat sliding: if the spot caused by sliding is 2½ inches or over in length on wheels under 80,000 lbs. capacity. Two inches in length on wheels 80,000 capacity and over. Care should be taken to distinguish this defect from worn through chill."

MR. GOODNOW: I would move that the same correction be made in wording that, to conform to the other.

THE CHAIRMAN: Any discussion? A motion will be in order.

A motion that the committee's report be adopted was made and carried.

THE SECRETARY: In that connection the committee recommends that, in case the three proposed changes referred to are adopted, that "Wheel defect gauge, figure No. 1, be changed to conform with recommended changes."

THE CHAIRMAN: That will go through without any action. Is there anything between rules 19 and 23?

THE SECRETARY: "Rule 23—Recommends that reference to 30,000 lbs. capacity be cut out of this rule as this class of equipment is practically retired from service, at least in the interchange of cars."

On motion, the recommendation was adopted.

THE CHAIRMAN: Is there anything between rules 23 and 32?

THE SECRETARY: "Rule 32—Your Committee would renew its recommendation of last year, being of the opinion that notwithstanding the action of the M. C. B. Association, that rule 32 and

arbitration case 655 do not coincide and that decision in question applies to rule 29, and recommends that the Arbitration Committee take necessary action to make rule and decision agree."

THE CHAIRMAN: That suggestion will be forwarded to the Arbitration Committee without any action. Anything on rule 33?

THE SECRETARY: "Rule 34—Eliminate, as when the revised rules take effect all cars offered in interchange must be equipped with air brakes."

Motion to adopt was carried.

THE CHAIRMAN: Anything between rules 34 and 36?

THE SECRETARY: "Rule 36—Should read: All cars offered in interchange must be equipped with air brakes, thus omitting that portion referring to date."

MR. PECK: I do not see any value in that, because when the revised rules go into effect next September that provision will be done away with.

THE CHAIRMAN: I do not believe any rule automatically changes unless it is changed by the action of the convention.

Motion to adopt was carried.

THE SECRETARY: "Rule 39—Changed to read: Steps, ladders, hand holds or running boards in bad order or insecurely fastened, absence of grab irons or hand holds, M. C. B. couplers or their attachments are required by law. Hand holds or grab irons must be of wrought iron or steel and secured by bolts or lag screws."

THE CHAIRMAN: That is the interpolation of "M. C. B. couplers or their attachments."

MR. GOODNOW: Then whatever change is intended under rule 45 is simply embodied in rule 39, making reference to the coupler attachments in that rule, as that practically covers the penalty advanced in the Interstate Commerce law.

MR. H. LARUE (C., R. I. & P. Ry.): Since the committee met, the last part of that proposed change was made, "Hand holds or grab irons must be of wrought iron or steel and must be secured by bolts or rivets on cars after January 1, 1908." I stand by that yet.

THE CHAIRMAN: Do you make that as an amendment?

MR. LA RUE: I am opposed to lag screws and I am not opposed to rivets.

MR. MANCHESTER: I move that the committee's recommendation be adopted.

Motion was carried.

THE CHAIRMAN: Anything from rules 39 to 45?

THE SECRETARY: "Rule 45—Eliminate account of reference to this being added to and contained in recommendation for revision of rule 39."

THE CHAIRMAN: That will naturally follow in case of the other rule having been adopted.

THE SECRETARY: "Rule 46—Omit reference to rule 45 and

add 'also uncoupling attachments of M. C. B. couplers,' making rule read as follows: Any company making improper repairs is solely responsible to the owners, with the exception of the cases provided for in rules 31, 42, 43 and 44, also in case it should be necessary to replace spindle with pocket attachment, also uncoupling attachments of M. C. B. couplers."

Motion to adopt was carried.

THE SECRETARY: "Rule 48 to 56 inclusive: Change the first paragraph of explanation following these rules to read as follows: The word coupler in above rules 48 to 53 inclusive means the coupler body only."

Motion to adopt recommendation was carried.

THE CHAIRMAN: Is there anything from rules 56 to 62?

THE SECRETARY: "Rule 62—Add clause to this rule as follows: 'All couplers and knuckles manufactured after September 1, 1907, must have name and class (or type) for identification of coupler or knuckle cast upon them.' "

Motion was made and seconded to adopt.

THE CHAIRMAN: It seems to me that is more a matter of standard practice than of rules. However, those in favor please say "Aye." Motion carried.

THE SECRETARY: "Rule 65, Figure 9-a—Your committee is of the opinion that the present splice and using 8 bolts, instead of 12 bolts, securing slab to sill would give satisfactory results. The question of a half-butt splice 30 inches long, using 8 bolts in securing the slab to the side of the sill, was also suggested instead of the splicing as shown in figure 9-a. Your Committee have no suggestions to make, simply bringing same to your attention."

THE CHAIRMAN: Do you desire any action on this?

MR. GOODNOW: No, I do not think so.

THE CHAIRMAN: Anything on rules between 65 and 76?

THE SECRETARY: "Rule 76—Add after words 'also show location of parts repaired or renewed,' 'and state if car repaired is empty or loaded' making rule read:

" 'When repairs of any kind are made to foreign cars a repair card shall be securely attached to outside face of intermediate sill between cross-tie timbers on wooden cars and on steel cars to cardboard located either on cross tie under car or on inside of side sill at the end of car. This card shall specify fully the repairs made, and reason for same, the date and place where made, and name of the road making repairs; also show location of parts repaired or renewed, and state if car repaired is loaded or empty, etc."

THE CHAIRMAN: What is the remainder of the rule?

MR. GOODNOW: The remainder continues the same as printed.

THE CHAIRMAN: It is understood the remainder will read the same as it is in the book.

Motion to adopt committee's recommendation was carried.

THE SECRETARY: "Rule 89—Your committee is of the opinion

that the prices of wheels and axles should be adjusted to meet the present conditions, but do not make a definite recommendation, other than suggest that the matter be referred to the Arbitration Committee with a view of having them make proper adjustment, also establish prices and credits for solid steel wheels and steel tired wheels in freight equipment."

THE CHAIRMAN: That is a suggestion only. Rules 89 to 94.

THE SECRETARY: "Rule 94—As in the case of rule 89, your committee also recommends that similar action be taken with reference to the prices of material under this rule, but do make a definite recommendation that labor charge be increased from 20c to 25c per hour; add prices for 10-inch air brake equipment; pressed and sheet steel; door for side of carriage or furniture car, wooden, each applied; no credit for scrap $5.00; door for end of automobile, wooden, each applied; no credit for scrap $5.50; pin lifter clevis 5c; pin lifter clevis link 2c; pin lifter clevis bolt 1c."

THE CHAIRMAN: What is your pleasure in regard to the definite recommendations?

A motion to adopt the committee's recommendations was carried.

THE SECRETARY: "Rule 105—Altering height of one end of car, net, increased to $1.25."

Moved and seconded that the recommendation of the committee be adopted. Motion carried.

THE SECRETARY: Rule 106—Add:

Draft timber, long, one replaced........................9 hours
Draft timber, one replaced when its center sill has been replaced ....3 hours
Draft timbers, long, two on same end replaced..........13 hours
Truck transom one and one spring plank in same truck replaced ....14 hours
Truck transom one and one truck bolster in same truck replaced ....15 hours
Siding removed and replaced per lineal foot from 10c to 15c.
Siding removed and replaced where nails are set and holes puttied from 12c to 20c.
Steel cars, straightening or repairing parts in place of damaged cars; also any parts that require straightening, repairing or renewing, not included on rivet basis, from 20c to 25c per hour.

Moved and seconded that the report of the committee with regard to rule 106 be adopted. Carried.

THE SECRETARY: "Rule 112—Your committee would recommend similar action regarding the increase in prices under this rule as given for rules 89 and 94."

Motion to adopt recommendation of committee carried.

THE SECRETARY: "Rule 113—First: Your committee believes that price should be established for settlement where cars are equipped with 10 inch air brake equipment and would recommend that $35 be allowed for same, making the first paragraph of rule

read: The settlement price of new 8 wheel cars shall be as follows, with an additional $27.50 for 8 inch and $35.00 for 10 inch for each car equipped with air brakes."

Motion to adopt recommendation of committee was carried.

"Second: That prices for bodies, wooden, composite or steel be increased 10% on figures now quoted in rule."

MR. GOODNOW: That should have read "also trucks."

On motion, the recommendation of committee was adopted.

"Third: Under trucks additional clause to be inserted covering those having steel or steel tired wheels making an additional allowance on trucks having this style, at the discretion of the Arbitration Committee."

The recommendation of the committee was adopted.

"Fourth: Cut out reference to four wheel equipment."

The recommendation of the committee was adopted.

THE SECRETARY: "Rule 114—Change to be made in this rule making the depreciation for bodies of cars with steel underframes at 5½% per annum. Also include in last sentence price of $35.00 for 10 inch air brake equipment."

Motion to adopt recommendation was carried.

THE SECRETARY: "Rule 115—Additional clause to be inserted covering settlement for destruction of cars which were racked for carrying coke and other purposes, actual cost of rack to be added to standard settlement price for such cars."

Motion to adopt foregoing recommendation was carried.

THE SECRETARY: "Rule 122—Exception to be made and added to this rule as follows: 'Except in case of trucks of 50,000 lbs. capacity or less when railway company destroying car may elect to retain trucks and settle for them at scrap or second hand value in accordance with M. C. B. rules, except those belonging to cars of individual ownership."

THE CHAIRMAN: I suppose that means trucks of cars of 50,000 lbs. capacity, does it not?

MR. GOODNOW: Yes.

THE CHAIRMAN: Would you accept that as a change in the phraseology?

MR. GOODNOW: Yes.

Motion to adopt the recommendation of the committee was carried.

THE SECRETARY: "Rule 125—Your committee desires to call your attention to the fact that in home routing cars for general repairs it very often occurs that unnecessary long haulage of same is made as well as causing considerable damage while en route in returning car via its original routing, and believe that this Club should go on record to the Arbitration Committee to have them take action whereby all unnecessary movement be eliminated and such car delivered to the original line over which car moved at

nearest junction point, and that this can only be protected by the Car Accountant of the owning road protecting this feature in furnishing home route for car. He to make arrangements to have car accepted at such junction point regardless as to whether or not delivered there in former movement."

THE CHAIRMAN: You have heard the recommendation. I think no action is necessary on that, only to refer it to the Arbitration Committee. Mr. Beecham might have something to say on that.

THE SECRETARY: How does that strike you, Mr. Beecham?

MR. BEECHAM: Mr. Chairman, I am in sympathy with the recommendation. I think that all home route cars should be filled out by the Car Accountant and that he should make the shortest cut that he possibly can in getting cars home. I do not know whether that is generally understood by the Car Accountants or not, but it has been the practice on our road for some time past for our Superintendent of Motive Power to send home route cars to our office to be filled out and we always cut out all unnecessary movements and get the car home by the shortest and most direct route.

THE SECRETARY: "Rule 129—Change to read 'Companies shall promptly furnish to each other, upon requisition and forward free over their own road material for repairs of their cars injured upon foreign lines excepting that the company having car in its possession at the time shall provide from its own stock the following:

Lumber, forgings, hardware stock, paint, hairfelt piping, airbrake material and all M. C. B. standard material.

Requisitions for such material shall specify that same is for repairs of cars giving number and initial of such car, together with pattern number or other data to enable correct filling of requisition."

Motion to adopt recommendations regarding rule 129 was made and carried:

APPENDIX.

Clause B of rule 2 to include damage to steam pipes whether by bursting or freezing, also lamps and other permanent fixtures of car, where cars are delivered under load locked and sealed and interior inspection cannot be made.

List price for maintaining passenger equipment in interchange to have corresponding action taken with same as recommended for rules 89 and 94 of the freight code with definite recommendation that:

Labor for lubrication be increased from 20c to 25c per hour.

Labor on repairs be increased from 25c to 30c per hour.

THE CHAIRMAN: You have heard the recommendation for changes of rules in the Appendix or passenger car rules.

Mr. La Rue: I would like also to include in that motion that on page 88, Item 60, a clearer interpretation be given of the price of scrap and steel tired wheels, on account of the difference in thickness of tires according to the make of the wheel. From first glance at that it seems all right, but when you come to settle for steel-tired wheels it makes a difference, as you will see by referring back to Fig. 4 on page 88, and Figs. 1, 2 and 3 on page 83. I would like to have an interpretation on that item.

The Chairman: Have you any sugestions to make as to that interpretation?

Mr. La Rue: It is up to the Arbitration Committee

The Chairman: Will the committee accept the suggestion to include that?

Mr. Goodnow: We will accept it, Mr. Chairman.

The Chairman: What is your pleasure in regard to this? It has been moved and seconded that these recommendations, together with also clearing up item 60, page 88, be adopted. All in favor please say "Aye." Carried.

That ends the revision of the Rules of Interchange.

The report of the committee as amended is as follows:

REPORT OF COMMITTEE ON PROPOSED REVISION OF THE RULES OF INTERCHANGE.

To the Members of the Western Railway Club:

Your Committee appointed at the February meeting of the Club to submit changes for use in revising the M. C. B. code of rules, beg to submit the following for your consideration:

Rule 7—Shelled out: wheels with defective treads on account of pieces shelling out; if the spots are over 2½ inches, or are so numerous as to endanger the safety of the wheel under cars of less than 80,000 lbs. capacity. 80,000 lbs. capacity and over, limit to be 2 inches.

Rule 9—Worn through chill: When the worn spot exceeds 2½ inches in length on wheels under cars of less than 80,000 lbs. capacity, and 2 inches on cars of 80,000 lbs. or over. Care must be taken to distinguish this defect from flat spots caused by sliding wheels.

Rule 19—Flat sliding: if the spot caused by sliding is 2½ inches or over in length on wheels under cars of less than 80,000 lbs. capacity. Two inches in length on wheels of cars of 80,000 lbs. capacity and over. Care should be taken to distinguish this defect from worn through chill.

Note. Wheel defect gauge, figure No. 1, to be changed to conform with recommended changes in rules 7, 9, and 19, should same be approved.

Rule 23—Recommend that reference to 30,000 lbs. capacity be cut out of this rule as this class of equipment is practically retired from service at least in the interchange of cars.

Rule 32—Your Committee would renew its recommendation of last year, being of the opinion that notwithstanding the action of the M. C. B. Association, that rule 32 and arbitration case 655 do not coincide and that decision in question applies to rule 29, and recommend that our Arbitration Committee take necessary action to make rule and decision agree.

RULE 34—Eliminate as when the revised rules take effect all cars offered in interchange must be equipped with air brakes.

RULE 36—Should read: All cars offered in interchange must be equipped with air brakes, thus omitting that portion referring to date.

RULE 39—Changed to read: Steps, ladders, hand holds or running boards in bad order or insecurely fastened, absence of grab irons or hand holds, M. C. B. couplers or their attachments as required by law. Hand holds or grab irons must be of wrought iron or steel and secured by bolts or lag screws.

RULE 45—Eliminate account of reference to this being added to and contained in recommendation for revision of rule 39.

RULE 46—Omit reference to rule 45 and add "also uncoupling attachments of M. C. B. couplers," making rule read as follows: Any company making improper repairs is solely responsible to the owners, with the exception of the cases provided for in rules 31, 42, 43 and 44, also in case it should be necessary to replace spindle with pocket attachment, also uncoupling attachments of M. C. B. couplers.

RULE 48 TO RULE 56 INCLUSIVE—Change the first paragraph of explanation following these rules to read as follows: The word coupler in above rules 48 to 53 inclusive means the coupler body only.

RULE 62—Add clause to this rule as follows: "All couplers and knuckles manufactured after September 1, 1907, must have name and class (or type) for identification of coupler or knuckle cast upon them."

RULE 65, FIGURE 9-a—Your Committee is of the opinion that the present splice and using 8 bolts, instead of 12 bolts, securing slab to sill would give satisfactory results. The question of a half butt splice 30 inches long, using 8 bolts in securing the slab to the side of sill, was also suggested instead of the splicing as shown in figure 9-a. Your Committee have no suggestions to make, simply bringing same to your attention.

RULE 76—Add after words "also show location of parts repaired or renewed," "and state if car repaired is empty or loaded" making rule read:

"When repairs of any kind are made to foreign cars a repair card shall be securely attached to outside face of intermediate sill between cross-tie timbers on wooden cars and on steel cars to cardboard located either on cross-tie under car or on inside of side sill at the end of car. This card shall specify fully the repairs made, and reason for same, the date and place where made, and name of the road making repairs; also show location of parts repaired or renewed, and state if car repaired is loaded or empty, etc.

RULE 89—Your Committee is of the opinion that the prices of wheels and axles should be adjusted to meet the present conditions, but do not make a definite recommendation, other than suggest that the matter be referred to the Arbitration Committee with a view of having them make proper adjustment, also establish prices and credits for solid steel wheels and steel tired wheels in freight equipment.

RULE 94—As in the case of Rule 89, your Committee also recommends that similar action be taken with reference to the prices of material under this rule, but do make a definite recommendation that labor charge be increased from 20c to 25c per hour; add prices for 10 inch air brake equipment; pressed and sheet steel; door for side of carriage or furniture car, wooden, each applied; no credit for scrap $5.00; door for end of automobile, wooden, each applied; no credit for scrap $5.50; pin lifter clevis 5c; pin lifter clevis link 2c; pin lifter clevis bolt 1c.

RULE 105—Altering height of one end of car, net, increased to $1.25.

RULE 106—Add:

Draft timber long, one replaced.................................. 9 hours
Draft timber long, one replaced when its center sill has been replaced .... 3 hours
Draft timbers, long, two on same end replaced ....13 hours
Truck transom one and one spring plank in same truck replaced....14 hours
Truck transom one and one truck bolster in same truck replaced....15 hours
Siding removed and replaced per lineal foot from 10c to 15c.
Siding removed and replaced where nails are set and holes puttied from 12c to 20c.
Steel cars straightening or repairing parts in place in damaged cars; also any parts that require straightening, repairing or renewing, not included on rivet basis, from 20c to 25c per hour.

RULE 112—Your Committee would recommend similar action regarding the increase in prices under this rule as given for rules 89 and 94.

RULE 113—First: Your Committee believes that price should be established for settlement where cars are equipped with 10 inch air brake equipment and would recommend that $35.00 be allowed for same, making the first paragraph of rule read: The settlement price of new 8 wheel cars shall be as follows, with an additional $27.50 for 8 inch and $35.00 for 10 inch for each car equipped with air brakes.

Second: That prices for bodies and trucks of wooden, composite or steel be increased 10% on figures now quoted in rule.

Third: Under trucks additional clause to be inserted covering those having steel or steel tired wheels making an additional allowance on trucks having this style, at the discretion of the Arbitration Committee.

Fourth: Cut out reference to four wheel equipment.

RULE 114—Change to be made in this rule making the depreciation for bodies of cars with steel under-frames at 5½% per annum. Also include in last sentence price of $35.00 for 10 inch air brake equipment.

RULE 115—Additional clause to be inserted covering settlement for destruction of cars which were racked for carrying coke and other purposes, actual cost of rack to be added to standard settlement price for such cars.

RULE 122—Exception to be made and added to this rule as follows: "Except in case of trucks of 50,000 lbs. capacity or less when Railway Company destroying car may elect to retain trucks and settle for them at scrap or second hand value in accordance with M. C. B. Rules, except those belonging to cars of individual ownership."

RULE 125—Your Committee desires to call your attention to the fact that in home routing cars for general repairs it very often occurs that unnecessary long haulage of same is made as well as causing considerable damage while enroute in returning car via its original routing, and believe that this Club should go on record to the Arbitration Committee to have them take action whereby all unnecessary movement be eliminated and such car delivered to the original line over which car moved at nearest junction point, and that this can only be protected by the Car Accountant of the owning road protecting this feature in furnishing home route for car. He to make arrangements to have car accepted at such junction point regardless as to whether or not delivered there in former movement.

RULE 129—Change to read "Companies shall promptly furnish to each other, upon requisition and forward free over their own road material for repairs of their cars injured upon foreign lines excepting that the company having car in its possession at the time shall provide from its own stock the following:—

Lumber, forgings, hardware stock, paint, hairfelt, piping, airbrake material and all M. C. B. standard material.

Requisitions for such material shall specify that same is for repairs of cars giving car number and initial of such car together with pattern number or other data to enable correct filling of requisition."

APPENDIX.

Clause B of rule 2 to include damage to steam pipes whether by bursting or freezing, also lamps and other permanent fixtures of car, where cars are delivered under load, locked and sealed and interior inspection cannot be made.

List price for maintaining passenger equipment in interchange to have corresponding action taken with same as recommended for rules 89 and 94 of the freight code with definite recommendation that;

Labor for lubrication be increased from 20 to 25c per hour.

Labor on repairs be increased from 25c to 30c per hour.

That a clearer interpretation of item 60, page 88, of the rules relating to the thickness of steel tired wheels be given.

T. H. GOODNOW,
H. LA RUE,
O. M. STIMSON,
J. W. FOGG,
JOS. E. BUKER,
Committee.

Chicago, Ill., April 2, 1907.

Next in order is the paper on "Electric Train Lighting," by Mr. O. W. Ott. I have pleasure in introducing him.

ELECTRIC TRAIN LIGHTING.

BY MR. O. W. OTT.

There are now in common use three principal systems for the lighting of trains by electricity, namely:—the Straight Storage Battery, the Axle Dynamo, and the Head End Systems.

In the *first system* storage batteries of sufficient capacity to furnish light during the entire time the train is on the road are carried on each car in battery boxes suspended under the car sills. This system is in use principally on trains which double back and forth on an overnight run, laying up in passenger yards at each end during the day, thus allowing the batteries to be charged. On one train on which this system is now in effect each car carries thirty-two cells of battery of 240 amp. hr. capacity and has 60 volt lamps. In this case the charging is done while the train lays over at one end only, making a round trip between charges, as the distance between terminals is only 280 miles.

In another instance on a round trip of 884 miles each car carried forty-eight cells of 160 amp. hr. capacity and was equipped with 96 volt lamps. In this case the charging was done in the passenger yards at both terminals.

To facilitate charging and also to distribute the load it is generally customary to equip cars of the straight storage system with a three-wire loop system train line, with connections between the cars.

The *second* or Axle Dynamo System involves lighting each car as an individual unit by means of a small generator which takes its power from one of the truck axles. This generator is suspended to the truck frame and driven from one of the axles, by either gears or a belt.

In order to have lights when the car is not in motion or when the generator is running below the critical speed it is necessary to have an auxiliary storage battery, and as a 32 volt circuit is the minimum, this means 16 cells of 240 amp. hrs. or more capacity.

On account of the varying speed to which the axle dynamo is subjected, a very sensitive regulator is necessary to control the generator output. At least in the better American systems a regulator is employed, although in the Stone system in vogue in England the generator speed is regulated by slipping the driving belt.

In order to have the generator always build up the voltage in the

same direction no matter which way the car is running, some automatic device must be employed to either change the field connections or rotate the commutator brushes.

Also to automatically cut the generator on to the line when the critical speed is reached and the generator voltage has built up to normal, a magnetically controlled switch is necessary. This automatic switch must also cut the machine off of the line when the speed has fallen below the critical point or the battery current would attempt to run the dynamo as a motor.

On account of the considerable range between the voltages of charge and discharge of the storage battery it is necessary to insert resistance in the lamp circuits when the generator is furnishing current, and then to automatically cut out the resistance, when the lamps are lighted off the batteries.

To summarize, the modern axle dynamo involves: First, a difficult problem of suspending a dynamo to the car truck frame to take power from an axle which has a considerable range of motion both horizontally and vertically; second, an automatic regulator; third, a pole changer; fourth, an automatic switch; and fifth, some form of automatically controlled rheostat to insert resistance in the lamp circuit.

On one road where some twelve axle dynamos of two different makes are now in operation on three different runs the dynamos are all 32 volt machines and it has been found necessary to use 32 240 amp. hr. cells of battery connected in two halves in parallel. More satisfactory results are found, however, where 60 volt machines are used with 32 240 amp. hr. cells all connected in series.

The *third* or *Head End System* consists in reality of the maintenance of a small electric power plant, to be run by steam from the locomotive, and located either in the baggage car or on the locomotive.

The first, and perhaps the most common set, was the small high speed reciprocating engine direct connected to a generator. This was followed by the DeLaval high speed turbo-generator set which run at 20,000 r. p. m. and was geared down to 2,000 r. p. m. Next and most modern is the Curtis direct connected on the same shaft turbo-generator set. These machines run at 3,600 r. p. m. and are made in 15, 20 and 25 K. W. sizes.

The question as to the necessity of auxiliary storage batteries to carry the lighting load when the steam supply is cut off when changing locomotives at division points, or when the train is cut in two and part of the cars isolated from the feeder wires of the train line, has been answered in various ways on different roads.

On some roads no batteries are carried, and resort is made to oil lamps or Pintsch gas to tide over the gaps. On one road service connections were made through the baggage car windows, thus temporarily lighting the train from the depot source of current.

On still another road a full set of batteries are carried on each car. The problem has also been solved by carrying two sets of batteries per train, one set located on the baggage car and the other on one of the last cars in the train. This division is made to light both halves of the train when the dining car is being cut out.

With the Head End System, in order not to have an excessive voltage drop and consequently dim lights on the last car of a train, the three wire loop system of wiring is necessary, and in order to take care of twelve or more cars 4/0 wires are commonly used.

On account of the necessity of an unbroken train line from one end of the train to the other, it is claimed that one of the principal disadvantages of this system is that it does not allow the addition of extra unwired cars in emergencies, except at the rear of the train. This problem has been partially solved by the use of roof connectors, and two wire overhead jumpers.* The roof connectors are placed on the ends of the cars between which extra cars are to be carried and the jumper is then passed over and secured to the roof of the dead car. The roof connectors are connected up in parallel with the vestibule connectors. Overhead jumpers are kept at terminal and division points where dead cars are liable to be inserted.

In emergencies where roof connectors are not available overhead jumpers have been used by bringing the ends down through the canvas diaphragms and making connections with the regular connectors.

Perhaps one of the most common sources of trouble with the Head End System has been the flexible connectors between cars. To get a coupler which will always give good contact, that will come apart without taking part of the vestibule with it when the train breaks in two, and that does not have an excessive first cost is considerable of a problem.

Another problem with the Head End System where batteries are carried is the charging of the batteries. As remarked in the Axle Light descriptions, there is quite a variation in the charge and discharge voltage curves of a storage battery. This means that to charge on the road, the charging voltage must be raised above the normal lamp voltage.

There are quite a few methods now in use for accomplishing this. When a part of the time on the road is during daylight the batteries can be charged by simply boosting the machine voltage and running the dynamo for charging only.

On one road only one set of batteries are carried, and they are all located on the same car as the dynamo. The cells are connected

*An overhead jumper consists simply of a pair of wires of sufficient length to pass over the roof of the dead car and extend down into the vestibules of the adjacent cars. The two wires are connected up to a male train line connector at each end, thus allowing connection to be made with the connectors in the vestibules or on the roofs of the adjacent cars.

up to form two half batteries with a rheostat on each circuit so that each half may be charged at the same time that the train is being lighted. In this instance, the dynamo is run only when the full lamp and battery load is on, being entirely shut down at 11:30 P. M. when all the lights but the night circuits are cut out. From 11:30 P. M. to daylight the load is then carried on the batteries.

On one road where the two sets of batteries at all times float in on the line and thus buck the dynamo the batteries are charged by boosting the voltage on the night circuits. This with an occasional full charge in the yards keeps the batteries in fair shape, although it considerably increases the lamps burned out on the night circuits.

An arrangement is now being tried on the road just referred to, where an end cell switch is placed in the circuit of each set of batteries whereby 48 of a total of 54 cells are cut in on the line whenever the dynamo is running and the 54 cells are cut in when the load is to be carried by the batteries. These switches are operated by the train electricians. The six end cells are replaced by fresh ones which have been fully charged in one of the passenger yards between every round trip.

Another alternative for charging the batteries which is in use on some roads is to charge the batteries entirely at the passenger yards and then connect them up independent from the train line with a throw-over switch so that the lamps may be lighted either from the train line or batteries. This switch is operated by the trainmen or the porters.

In order to make a comparison of the first cost and cost of operation of the three systems assume as a basis an eight-car train, doubling back and forth over a 500-mile run over night and laying up in passenger yards during the day. Assume a fourteen-hour schedule with a pair of trains, one leaving each terminal at 6 P. M., and arriving at the other terminal at 8:00 A. M., the next morning. Let each train be made up as follows: Mail car, express car, combination baggage and smoker, chair car, coach, dining car, standard sleeper, and observation stateroom sleeper. The dining cars serving supper and breakfast and running back and forth over a distance of 80 miles at each end of the run on a schedule time of 2 hours for the 80 miles.

For a well lighted train the standard lamp equipment for the various cars is about as follows: 60 ft. baggage and express cars, 12-16 c. p. lamps; 60 ft. mail cars, 24-16 c. p. lamps; 70 ft. combination baggage and smoking cars, 4-8 c. p. lamps and 20-16 c. p. lamps; 70 ft. chair cars, 31-8 c. p. and 22-16 c. p. lamps; 70 ft. coaches, 40-8 c. p. lamps and 22-16 c. p. lamps; dining cars an average of 30-8 c. p. and 40-16 c. p. lamps; and sleepers an average of 40-8 c. p. and 32-16 c. p. lamps each.

Using these figures for lamp equipment our sample train would

contain 185-8 c. p. and 204-16 c. p. lamps with a grand total of 389 lamps. Using a figure of ½ an amp. at 110 volts for the current consumption of a 16 c. p. lamp, the total load would be 148.25 amp. at 110 volts or 16.3 K. W.

From tests made on a train very similar to the sample train by Mr. Edwrad Wray of the University of Wisconsin, the actual running load on our sample train would average up as follows: Leaving the yards at 5:30 P. M. and until cutting out the dining car at 8:00 P. M., the load will average 16 K. W. From 8:00 P. M. until about 11:00 P. M., the load will average 14 K. W. From 11:00 P. M. until 8:00 A. M. the load will average about 7 K. W., as about 11:00 P. M. all the lights except those on the night circuits are cut out.

By multiplying the rates by the time in effect the round trip current consumption will be found to be 290 K. W. hrs. This figure to be taken as the actual consumption of current at the lamps.

As our pair of trains will make 365 round trips a year this gives a yearly consumption of 105,850 K. W. hours. The first cost of equipment for the pair of sample trains will be as follows:

HEAD END SYSTEM.

2 Curtis turbo-generators, 25 K. W. @ $1,400.00	$ 2,800.00
Switch boards, instruments, steam fittings and piping, wiring and installing dynamos complete. 2 cars @ $400.00	800.00
4 sets of storage battery, each of 54 cells, 240 amp. hr. cap., 216 cells @ $20.50	4,428.00
Overhead train line (3-4/0 wire with Gibbs connectors), 16 cars @ $130.00	2,080.00
Battery boxes and crates. 4 cars @ $100.00	400.00
Wiring and fixtures, exclusive of train line, 2 chair cars, 2 coaches, 2 dining cars, and 4 sleepers—10 cars @ $300.00 average	3,000.00
Wiring and fixtures, exclusive of train line, 2 comb. cars @ $180.00	360.00
Wiring and fixtures, exclusive of train line, 2 mail cars and 2 express cars, 4 cars @ $30.00 average	120.00
Total for 16 cars	$13,988.00
Average per car	874.25

STORAGE BATTERY SYSTEM.

Battery—16 sets—32-240 amp. hr. cells each set, 512 cells @ $20.50	$10,496.00
Battery boxes and crates, 16 cars @ $70.00	1,120.00
Overhead train line (3-4/0 wire with Gibbs connectors), 16 cars @ $130.00	2,080.00
Wiring and fixtures, exclusive of train line, same as above 16 cars.	3,480.00
Total for 16 cars	$17,176.00
Average per car	1,073.50

AXLE DYNAMO SYSTEM.

Generators, regulators and suspensions, 16 cars @ $670.00	$10,720.00
Battery, 32 cells 240 amp. hr. per car, 512 cells @ $20.50	10,496.00
Battery boxes and crates, 16 cars @ $70.00	1,120.00
Wiring and fixtures, exclusive of train line, same as above, 16 cars	3,480.00
Application of Axle Dynamos to car, 16 cars @ $60.00	960.00
Total for 16 cars	$26,776.00
Average per car	1,673.50

The figures given above for wiring and fixtures on all the cars except mail and express will cover the cost of changing the Pintsch or acetylene into combination electric fixtures, the addition of bracket side fixtures and the laying of all wire in conduit.

Where plain socket fixtures are placed along the under side of the lower deck crown mould with the wires run in the moulding and the oil or gas lamps left undisturbed the cost exclusive of the train line would not be over $50.00 per car.

It will be noted that the train line has not been included in the Axle Dynamo System estimate, although to facilitate handling axle lighted cars in head end trains, it would be advantageous to have train lines applied. With the storage battery system the train line is absolutely essential for charging purposes.

It will also be noted that 32 cells of 240 amp. hr. batteries have been specified for the Axle Dynamo cars. A smaller battery capacity than this has not been found satisfactory and in several instances 32 cells of larger capacity have been applied.

COST OF OPERATION.

Current Cost—Head End System—With the Head End System with a 4/0 wire train line it requires 114 volts at the generator to give 110 volts at the lamps on an eight car train. This gives 96.4 per cent efficiency of transmission. The storage batteries will be required to carry the lighting load for average periods of twelve minutes each at four engine changes and four dining car cuts in the train per round trip. Noting that two engine changes are made during periods of heavy load and two at the periods of the light load and that when the dining car cuts are made only the two rear cars—the sleepers—are lighted from the batteries, it will be found that the total battery discharge will be about 10 K. W. hrs. per round trip.

Assuming a watt efficiency for the batteries of 50 per cent. then to make up the current loss involved in using the batteries, the total K. W. hr. consumption will be increased from 290 to 300 K. W. hrs. per round trip.

Taking the efficiency of transmission into account to give 300 K. W. hours at the lamps the generator output will have to be 311.2 K. W. hrs. This means that for a lamp consumption of 105,850 K. W. hrs. per year the generators will be required to put up 113,588 K. W. hours.

The tests conducted by Mr. Wray on a 25 K. W. turbo-generator set showed an average steam consumption of about 90 lbs. of steam per K. W. hour with the load averaging around 15 K. W. and about 140 lbs. per K. W. hour for a load of 7 K. W. These figures both for a K. W. hour delivered at the switch board.

Dividing the current consumption up we will find that 55 per

cent will be generated at the 15 K. W. rate and 45 per cent at the 7 K. W. rate. This gives a total steam consumption per year for the pair of trains of 12,778,650 lbs.

Tests on passenger runs similar to that of the sample train have shown an average evaporation of 5.5 lbs. of water per pound of coal actual with coal at $2.00 per ton delivered at the locomotive. Then the total coal consumption per year would be 2,323,390 lbs., or 1,161.69 tons at a cost of $2,323.38.

CURRENT COST STRAIGHT STORAGE SYSTEM.

For the straight storage system the current cost can perhaps be most accurately derived by assuming a value of 2½c. per K. W. hr., delivered at the passenger yards. This figure would perhaps be a trifle low for small isolated power plants. From the tests conducted by Mr. Wray on a storage battery lighted train which was equipped with batteries which were somewhat old and worn out, the average watt efficiency was found to be 49.2 per cent. In these tests readings were taken of input and output on four cars for a period of six days.

It would probably be more fair to assume a watt efficiency of 65 per cent as representing average conditions, under which straight storage systems operate.

With 65 per cent efficiency 105,850 K. W. hrs. at the lamps would require 162,846 K. W. hrs. at the passenger yard terminals at a total cost of $4,071.15 per year.

CURRENT COST AXLE DYNAMO SYSTEM.

For the axle dynamo system the current cost can be figured as follows:

In tests made by Mr. Wray, previously referred to, covering five different cars having axle dynamos the average total efficiency was 42.6 per cent. This efficiency was derived as follows: The lamp consumption divided by the total generator output was multiplied successively by the generator efficiency and the belt drive efficiency. The belt drive efficiency was assumed at 97 per cent or 3 per cent slip.

It would probably be safe to assume 50 per cent total efficiency as representing average conditions.

Changing the total yearly consumption of 105,850 K. W. hrs. into H. P. we have 141,890 H. P. hrs. at the lamps. This figure divided by 50 per cent efficiency gives a total of 283,780 H. P. hrs. taken from the wheels

Let us figure only the extra coal required at the locomotive due to the increased train resistance making allowance for power taken from the axles when the locomotive is drifting and not working steam.

Tests on passenger locomotives on a very level division showed

a ratio of 94 per cent between total time using steam and total time in motion, while on a very hilly division this ratio was 76 per cent. As these two divisions will fairly represent the extreme conditions found on the average road it would be safe to place the figure for the sample train at 85 per cent., the average of the two.

A part of the time in motion while not using steam is due to the making of stops and hence a portion of the time the running speed will be below the critical speed of the axle dynamos. This critical speed is generally about 20 miles per hour.

A figure of 90 per cent would probably fairly represent the portion of the total power taken from the car axles while the locomotive is using steam. Therefore 90 per cent of 283,780 H. P. hrs. or 255,402 H. P. hrs. will have to be accounted for by extra coal consumed at the locomotive.

An average passenger locomotive will deliver a H. P. hr. at the draw bar for 8 pounds of coal at $2.00 per ton. This makes a total coal consumption of 2,043,216 lbs. or 1,021.6 tons at a cost of $2,043.20 per year for the pair of trains.

COST FROM INCREASED WEIGHT OF TRAIN.

	Pounds.
Head End System, Weights.	
2 Turbo-generators 25 K. W. at 3,600 pounds	7,200
2 Switchboards, piping, fittings, etc., at 600 pounds per car	1,200
216 cells of battery at 100 pounds	21,600
4 cars battery boxes at 800 pounds per car	3,200
Total for 16 cars	33,200
Average per car	2,075
Storage Battery System, Weights.	Pounds.
Battery 16 cars, 32 cells, each at 100 pounds	51,200
Battery boxes and crates, 16 cars at 600 pounds	9,600
Total for 16 cars	60,800
Average per car	3,800
Axle Dynamo System, Weights.	Pounds.
Generators, suspensions and regulators, 16 cars at 1,100 pounds	17,600
Battery 16 cars, 32 cells, each at 100 pounds	51,200
Battery boxes and crates, 16 cars at 600 pounds	9,600
Total for 16 cars	78,400
Average per car	4,900

Consider only the cost in coal at the locomotive for carrying this extra weight. From tests made on passenger trains which run on a schedule very close to that of our sample trains, about 20 lbs. of coal was consumed per 100 ton miles with coal at $2.00 per ton.

As our assumed mileage was 500 miles between terminals we will have a total yearly mileage of 500x365 or 182,500 miles for each car.

Then for the Head End System we would have 16.6 tons x 182,500 miles or 3,029,500 ton miles with a coal consumption of 605,900 lbs.. or 302.95 tons at a cost of $605.90 per year.

For the Storage Battery System remembering that the dining cars only run a distance of 80 miles at each end of the run, we would have 26.6 tons x 182,500 miles and 3.8 tons x 58,400 miles, or a total of 5,076,420 ton miles with a coal consumption of 507.64 tons at a cost of $1,015.28.

For the Axle Dynamo System using the same method of figuring we would have 6,545,910 ton miles with a coal consumption of 654.59 tons at a cost of $1,309.18.

LAMP RENEWAL COST.

Head End System—As the battery charging for the sample trains under this system was figured as being done on the road by boosting the voltage on the night circuit lamps the number of lamps burned out per month will be rather high. Records kept have shown a mortality of 25 per cent per car per month. With our sample trains each having 389 lamp bulbs, or a total of 778 for the pair of trains, we would have to renew 194.5 lamps per month, having an average value of 20c. each. This would make the yearly lamp bill for the two trains come to $466.80.

Straight Storage System—With this system the lamp mortality is a minimum as very seldom does the lamp voltage rise above normal. Records have shown a mortality of about 8 per cent per car per month. Figuring as above the lamp mortality for the two trains would be 746 bulbs at a cost of $149.20 per year.

Axle Dynamo System—The tests conducted by Mr. Wray showed that even though a lamp resistance is employed when the lights are lighted from the generator there are periods when the lamps are required to take an excessive voltage. This is especially evident when all but the night circuit lights are cut out and the dynamo is charging the batteries. Records kept have shown a lamp mortality for axle dynamo cars of practically the same figure as under the head end system quoted above, i. e., 25 per cent per car per month. This gives a yearly bill of 2,334 lamp bulbs at a cost of $466.80 for the pair of trains.

BATTERY DEPRECIATION COST.

For the Head End System and the Straight Storage System the writer would estimate the life of the average storage battery to be five years of service for train lighting and then several more years' service as fan batteries or for private car work. Take depreciation at 15 per cent for five years and then 25 per cent of the original cost as the scrap value of the batteries for fan service.

With the Axle Dynamo System the life of the batteries is an extremely variable quantity. Instances have occurred where batteries have gone to pieces in eighteen months while in other instances after three or four years of service the batteries were still

in fair shape. Assume 20 per cent depreciation for four years and a scrap value of 20 per cent at the end of the four years for service as fan batteries.

MAINTENANCE COST.

Under this head include cost of electrical attendance on the road or in passenger yards. Repairs, oil, waste, etc.

Head End System—The largest single item for this system will be train electrician attendance. On one road where the baggagemen run the dynamos and the trainmen are required to look after the train line connections between the cars, the baggagemen are paid $20.00 per month extra in addition to their regular rates as baggagemen. As our sample trains would require a pool of four baggagemen, the attendance cost would be $80.00 per month or $960.00 per year, if handled by baggagemen.

With regular train electricians the pair of trains would require 2½ men. By the fraction is meant that each of two regular train electricians would be relieved at regular intervals by a substitute from the yard electricians or an extra man. Then each regular electrician would make 146 round trips per year with 73 trips by the extra man. Figuring these men at $1,000.00 per year each, the attendance cost would be $2,500.00 per year for the two trains.

The yard attendance for the Head End System would be fairly placed at three hours per day at each terminal or a total of six hours at 25c. or $1.50 per day. This makes a yearly bill of $547.50 for the pair of trains. This would include testing out the car circuits, renewing burned out bulbs, flushing and cleaning batteries, etc. Repairs to the generator set, train line connectors, broken battery jars, etc., could be safely placed at $300.00 for the two trains per year.

Another item for the head end system would be the steam hose cost. Assume that the generator is located in one end of the express car on the sample train. Then between the locomotive tender and the front end of the express car, remembering that there is a mail car intervening, there will be a total of four steam hose per train, subjected to steam pressures varying from 80 to sometimes 125 lbs. gauge. The average life of hose under these conditions is about one and one-half months. This means that each hose will have to be renewed eight times per year. Then the yearly bill would be 64 steam hose at a renewal cost of $1.25 each or a total of $80.00.

With the generator set placed crosswise of the car the daily oil and waste bill would be 2 quarts engine oil, 1 quart valve oil, and 1 lb. waste at a cost of $0.45 per day or $164.25 per year for the two trains. With the generator placed lengthwise of the car the oil bill would be cut in half.

Straight Storage System—The largest single item under maintenance cost under this system would be the employment of a regular man at each terminal for charging purposes. However, this man could test out the car circuits, renew burned out bulbs, flush and clean batteries and make all necessary repairs. Two men at $2.50 per day would give a yearly bill of $1,825.00. Broken battery jars, repairs to train line connectors, etc., would probably be safely covered by $100.00 per year for the two trains.

Axle Dynamo System—For this system for yard attendance, 30 minutes per car for one electrician to test out the circuits, renew bulbs, test out the regulator, look over the batteries and the generator when necessary would probably be a safe figure. This for an eight-car train would mean four hours a day at each terminal, or a total of eight hours at 25c. or $2.00 per day, or $730.00 per year for the pair of trains. A figure of $5.00 per car per month would be conservative, to cover all repairs to the generator, regulators and suspensions, also renewals of broken battery jars, lost belts, etc. The size of this bill will depend considerably upon the ability of the men handling the cars, both in the yards and on the road. An axle dynamo in careless or inexperienced hands is an expensive proposition, and there is no doubt whatever in the mind of the writer that a railroad will make a very serious mistake in employing cheap help to take care of axle dynamos.

Using the figure of $5.00 per car per month, we have a yearly bill of $960.00 for the 16 cars in the two trains.

For the axle dynamos on the sample train the oil bill would be about ½ pint of engine oil per car per round trip with oil at 45c. per gal. Then for the 16 cars the daily bill would be 2 quarts at a cost of 22½c. This would give a yearly bill of $82.12.

Before summarizing the various items under cost of operation it should be noted that there is one point of cost which can not be estimated, i. e., the value of the room displaced in the baggage car by the generator set under the Head End System.

On one installation employing a high speed reciprocating engine set a distance of about 12 feet at one end of a 60-foot car was occupied, while on another road a 15 K. W. turbo-generator set was partitioned off with stanchions in one corner of the car in a space 3 feet 6 inches x 8 feet. With a 25 K. W. turbo-generator set placed crosswise of the car a minimum distance of 6 feet at one end of the car will be required. The same generator placed longitudinally will require 8 feet 6 inches.

DEPRECIATION COST ELECTRICAL EQUIPMENT.

As the wiring and fixtures are common to all three systems and are essentially a part of the car no depreciation charge will be made on them.

With the head end system the principal electrical equipment the generator set and fittings are enclosed from the weather in the baggage car and with regular train electricians receive the care which is their due. Therefore 5 per cent would probably be a safe figure.

With the Axle Dynamo System the generator itself, which is the principal item of the electrical equipment, is carried in an extremely exposed place and is subject to varying conditions of weather and track. For the generator and suspension 15 per cent depreciation and for the regulator 5 per cent depreciation would be safe figures.

Instead of dividing the depreciation up the writer has assumed an average figure of 10 per cent for the generator regulator and suspension.

COST OF OPERATION.

Head End System.	
Current cost	$ 2,323.38
Weight cost	605.90
Interest on investment @ 5%	699.40
Depreciation on turbo-generator and fittings @ 5%	180.00
Depreciation on batteries @ 15%	664.20
Train electrician attendance	2,500.00
Yard electrician attendance	547.00
Lamp renewals	466.80
Oil and waste	164.25
Repairs	300.00
Steam hose cost	80.00
Total 16 cars	$ 8,530.93
Average for one car	533.18
Straight Storage System.	
Current cost	$ 4,071.15
Weight cost	1,015.28
Interest on investment @ 5%	858.80
Depreciation on batteries @ 15%	1,574.40
Yard attendance	1,825.00
Lamp renewals	149.20
Repairs	100.00
Total for 16 cars	$9,593.83
Average per car	599.61
Axle Dynamo System.	
Current cost	$ 2,043.20
Weight cost	1,309.18
Interest on investment @ 5%	1,338.80
Depreciation on axle dynamos, regulators and suspension, average @ 10%	1,072.00
Depreciation on batteries @ 20%	2,099.20
Yard attendance	730.00
Lamp renewals	466.80
Repairs	960.00
Oil	82.12
Total for 16 cars	$10,101.30
Average per car	631.33

In conclusion, it will be noted that for the pair of sample trains chosen the order of preference as to first cost and cost of operation would be: First, the Head End System; second, the Straight Storage System, and third, the Axle Dynamo System. It does not necessarily follow, however, that in all cases the Head End System would be most advantageous. Instances have occurred where all three systems were used on one train.

An important feature of electric train lighting from the standpoint of the traveling public is uniformity of voltage at the lamps. A drop of a few volts below the normal voltage will cause a very annoying decrease in the candle power of the lights. In respect to ability to maintain a constant lamp voltage the first choice undoubtedly rests with the Head End System as with first class electricians there is no reason why a predetermined voltage cannot be maintained. With the Axle Dynamo System the two main factors controlling the voltage at the lamps are the number of lights burning and the condition of battery charge. In some axle systems these factors are taken care of better than in others, but even in the best some variation in lamp voltage will result. From the nature of the storage battery itself the voltage at the lamps with the Straight Storage System is a maximum when the train starts out and then gradually falls as the batteries discharge. The higher the capacity and the more fully charged the batteries are the less will be this voltage drop and resulting decrease in candle power.

As the total tonnage of the modern passenger train is being steadily increased by the use of larger and heavier cars and more of them, it might be interesting to compare the additional load imposed upon the locomotive boiler, and consequently upon the fireman, by lighting the train electrically by the three systems under discussion.

Using a one-way trip as a basis, the additional coal required will be made up of two items, that required to generate the current with the head end and axle dynamo systems and that required to pull the additional weight for all three systems, as follows:

System	Coal for Current		Coal for Weight		Total	
	One way Trip lbs.	Per Hour lbs.	One way Trip lbs.	Per Hour lbs.	One way Trip lbs.	Per Hour lbs.
Head End............	3182	227	830	59	4012	286
Storage...............	....	....	1390	99	1390	99
Axle Dynamo..........	2800	200	1793	128	4593	328

For dining cars, parlor cars, mail cars, or any individual car for that matter that is to be electric lighted, and is required to be used on more than one train or pair of trains, the writer would recom-

mend the Axle Dynamo System. The main features of the Axle Dynamo System is that each car is a complete unit in itself and is not tied down to any given locality.

For the Straight Storage System the main features are simplicity of operation while on the road and the least number of parts to maintain.

An important field which will probably develop for the Head End System will be the lighting of suburban trains. As a rule no changes in locomotives or cars are made on suburban runs and hence no batteries would be necessary. A 15 K. W. turbo-generator could be placed on top of the locomotive boiler and run by the engineer with but little more trouble than the present electric head light sets.

For protection purposes an extra locomotive could be fitted up with the necesary wiring and piping and a suitable saddle casting so that in an emergency the turbo-generator could be readily transferred from the regular locomotive to this protection locomotive and the wiring and piping connected up in a short time. The first cost for fitting up a locomotive with a 15 K. W. turbo-generator would be about $1,420.00 and for the protection locomotive $160.00.

Using a 2/0 wire train line with plain and simple socket fixtures placed along the lower deck crown mould with the wires run in the moulding the cost for wiring the average 50 to 60 ft. suburban car would be about $150.00.

Figuring one locomotive to six cars the total cost per train of six cars would be $2,480.00, or an average of $413.33, which figure would compare very favorably with either Pintsch or acetylene gas.

As to cost of operation:—With the turbo-generator on the locomotive full boiler pressure could be used with but a short length of pipe between the boiler and the inlet valve and thus some economy effected in the steam consumption. With no batteries to maintain or cause trouble the main items of expense would be, extra coal at the locomotive, lamp renewals, repairs to train line and turbo-generators, and some roundhouse electrician attendance.

Assume a suburban train of six cars, each car having 24 16 c. p. lamps and burning the lamps for a period of six hours per day. A conservative estimate per car per year would be as follows:

Interest on investment @ 5%	$ 20.65
Depreciation and repairs to locomotive generator and equipment @ 15%	35.50
Current cost—Coal	49.25
Lamp renewals	4.80
Oil and waste	10.00
Yard electrician, attendance and repairs	18.00
Total cost per car per year	$138.20

APPENDIX.

COST OF OPERATING PER CAR PER YEAR.

	Head End System.	Straight Storage System.	Axle Dynamo System.
Current cost	$145.21	$ 254.45	$ 127.70
Weight cost	37.87	63.46	81.82
Interest on Investment	43.71	53.67	83.68
Depreciation on Batteries	41.51	98.40	131.20
Depreciation on Turbo-Generator and fittings	11.25	......	......
Depreciation on Axle Dynamos	....	......	67.00
Train Electricians, attendance	156.25	......	......
Yard Electricians, attendance	34.19	114.06	45.62
Lamp renewals	29.18	9.32	29.18
Repairs	18.75	6.25	60.00
Oil and Waste	10.26	......	5.13
Steam Hose cost	5.00	......	......
Total cost per car per year. Operation	$533.18	$ 599.61	$ 631.33
First cost per car. Equipment	874.25	1,073.50	1,673.50
Weight of equipment per car, lbs	2,075	3,800	4,900

THE CHAIRMAN: I think we have been favored with an unusually critical analysis of this subject. I understand there are a number of gentlemen present who are not members of the Club who are interested in this subject, and in accordance with a custom which sometimes obtains (I do not think there will be any objection to it), we will be glad to give them the freedom of the floor to make any remarks. The subject is a very live one, and we will be glad to have their discussion.

MR. A. J. FARRELLY (E. E., C. & N. W. Ry.): I would like to ask the reader of the paper to tell us how he gets at the cost of steam hose to get the figures. If he can tell me how he does that it will help me out in my future work.

THE CHAIRMAN: Mr. Ott, will you kindly take a note of all the inquiries and answer in your final summing up.

MR. C. R. GILLMAN (E. E., C., M. & St. P. Ry.): I would like to ask Mr. Ott in regard to using forty-eight cells with 96-volt lamps—is that more advantageous than a smaller number of larger capacity cells?

MR. E. JANSEN (I. C. R. R.): I am but a listener tonight. I have no questions and no comment except to say that the prices appear to me rather high, especially on the generator sets,—they run about 15 to 20 per cent higher, and also on train line connected with 3-4/0 in a 70-foot car, including connectors.

MR. W. E. SYMONS: There is not anything to be said on this paper, except to endorse it: One or two questions occurred to me, however, in connection with the paper, that I would be glad if the author would refer to, or explain, in his closing remarks. On page 2, second paragraph, a condition is presented, which suggests the

possibility of the battery current transforming the dynamo into a motor. I would be glad if the author will advise if this would not, under the conditions described, become a scientific and absolute certainty?

On page 6, in summing up the cost of operation for the head end system, allowance is made for 12 minutes in changing engines, and while on most of our railroads, these changes are made in much less than 12 minutes, yet there are times when a train will stand for half an hour or longer without any engine coupled on, and as this is liable to occur early in the evening when all of the lights in the entire train are needed, it occurred to me, that possibly there should be a wider latitude of time provided for in the way of additional storage batteries so as to prevent the possibility of a train being poorly lighted, or in total darkness on account of the limited storage supply.

On page 8, the item of the amount of coal per horse power per hour attracted my attention; 8 lbs. being mentioned as the basis of computation, and I would be very glad to know if it is not reasonable to expect a much more economical performance, particularly so with a passenger engine. It seems to me, that I have heard some figures quoted of a locomotive engine delivering a horse power per hour at the draw-bar with less than 3 lbs. of coal, possibly about 2, and while this was probably from laboratory tests, yet it seems to me the range of difference as between 2½ and 8 was rather wide, and that we might reasonably expect a little more economical result in actual locomotive service than 8 lbs.

In the preparation of the extra engines for protective purposes, mentioned on page 14, the idea seems a good one, and the cost of application is not open to criticism; it occurred to me, however, that its retention in an available location might in many cases necessitate the engine being practically taken from service. However, the author may have in view, and doubtless has, on all of these points, a method of solution, that will make the matter much clearer than anything that may have prompted my inquiry, or criticism.

Mr. Farrelly: In regard to the question of lighting cars, on page 4, I notice the equipment of 60-foot mail cars is given as 24 16-candle power lamps. Our practice is to install 36 8-candle power lamps. For instance, take the 70-foot chair car, 31 8-candle power and 22 16-candle power, and 70-foot coaches, 40 8-candle power and 22 16-candle power, and so on. It has been our practice to cut out all the 16-candle power and install the same number of 8-candle power, making them all 8 instead of 16. We find it gives as good results and as satisfactory.

On page 8 I would call attention to the critical speed of the axle dynamos. It says: "This critical speed is generally about 20 miles per hour." On the five different sets that we have the critical speed runs from about 9 to 12 and in no case exceeding 15 miles.

In regard to the last paragraph relative to the cost of hauling equipment, I believe Mr. Deems, of the N. Y. Central, places the cost of hauling a ton mile at three mills. That is a conservative estimate; I have heard it placed as high as five, but three, as Mr. Deems would estimate (I presume he has good authority, that is only the cost of hauling equipment), is above what Mr. Ott shows.

MR. CHAIRMAN: Gentlemen, we would like to thresh this subject to a conclusion tonight as far as we can.

MR. M. K. BARNUM (C., B. & Q. R. R.): Mr. President, I will not attempt to enter into any technical discussion, but I have been impressed with the idea that Mr. Ott's figures are very conservative, and that an extensive record of the cost of maintenance and operation of almost any of the lighting systems which he describes would be apt to raise the figures above those given in the paper.

I have checked up the cost of hauling dead weight in freight trains, and, taking only those items which would be affected by increasing the dead weight, and not including anything for general percentages, supervision, or station service, I have come to the conclusion that for freight trains two mills per ton mile is about right; it is probably a little low, but in figuring the cost of hauling additional dead weight, it is certainly conservative. Applying this charge to the weights of the various types of electric apparatus, it would give an increased cost per car per year of $140 for the head end, $266 for the storage, and $343 for the axle system, which is quite a good deal above the figure given by Mr. Ott. It seems fair to use the same figure for a passenger train.

Some of the other items seem lower than an extended test would show.

The electric light is certain to be the preferred light on the best class of passenger trains in the future, and while we are getting some excellent results from acetylene lights, there are some objections which will probably militate against their general use; so it devolves upon the mechanical talent of the railroads to perfect and make electric lighting as cheap and satisfactory as possible. Mr. Ott's paper is a very valuable record of tests which will assist in carrying out future improvements.

A MEMBER: I would like to ask a question. On page 10, under "Maintenance Cost," he has this statement:

"With the generator set placed crosswise of the car the daily oil and waste bill would be two quarts engine oil, 1 quart valve oil, and 1 lb. waste at a cost of $0.45 per day or $164.25 per year for the two trains. With the generator placed lengthwise of the car the oil bill would be cut in half." I would like to ask him in his closing statement if he can tell us why.

MR. FARRELY: On page 9 the author says that after five years' service for train lighting the batteries may be used on private cars.

I think that if I were to put batteries on private cars after five years' service I would be looking for a job after the first of May.

THE CHAIRMAN: This paper calls considerable attention, in my mind, to the difference in cost of maintenance of different systems, giving preference to the head end system. It occurs to me that there is an analogy between this situation and that of heating cars. We used to heat cars with stoves and then we commenced with the Baker heaters, which seems to me to be analagous to the axle light, and finally when a road got so well equipped with terminal facilities and that sort of thing, they generally put in straight steam on all cars and took care of cars at terminals. That seems to be analagous to the situation where you could use the head end system, running your trains through from end to end, and it is quite apparent that the cost of heating trains with direct steam without those intermediaries will be cheaper than the individual units, and it would seem to be the same with regard to electric lights. We are, however, in the West, under the necessity of having separate units in many cases on account of the way in which our trains are split up. We may start out of the terminal with a full train and go to a division point and cut into two or three or half a dozen, and there is a constant change in the makeup of the trains over a great portion of this western country. It will be a long time before we can come to head end lighting, as a general proposition; it looks to me that we have got to look to the fullest development of the single unit system. Is there any further discussion?

MR. SYMONS: In connection with the very appropriate remarks of our Chairman on the advisability, or adaptability, of the use of the single, or independent unit system on each car, I would like to add, that while the conditions are, as described in the west, similar conditions also prevail in many parts of the east.

Some years ago I was connected with a large system of roads, which with other lines along the Atlantic sea board operated through passenger train service from New York to Florida; the train was electrically lighted, using what was called the "Head end System." We found it necessary, however, to also equip the cars very liberally with storage batteries, and while this action at first produced some criticism, an investigation of the conditions showed the necessity of this, for the reason, that our train made up in New York entered about 4 Union Stations where in changing engines the out-going engine was coupled to the rear end of the train, and the train would be hauled backward over that district, or division; this occurred several times in going 1,000 miles; there being one piece of track 400 miles long over which the train was sometimes hauled backward, thus relying entirely on storage batteries for electric light, although we had the Head End System with a high-priced electrician on the rear of the train doing nothing; such conditions as these possibly are rather infrequent. The breaking up

of trains, however, for the purpose of adding extra cars at different points along the Line of Road, or taking off cars is a necessity. and will be practiced for many years to come. The train lighting should be of such a character, or such a system used, that such necessary changes, as may be made to—passenger trains en-route, will not interefer with the lighting system.

Mr. A. E. Manchester (S. M. P., C. M. & St. P. Ry.): I am very glad that this paper has come to us, as it gives a comparison at least between the different systems and I feel that the author has used practically the same figures, in giving the values of each of the systems; he has explained in his paper that there are many places where a combination of the systems will have to be used to work out satisfactorily.

My belief is that as we develop and become more civilized in the West we will have more through and continuous trains and service, and that it will be possible to handle larger numbers of trains from the head end system.

I do not quite agree with the chairman's thoughts in connection with the unit system. I would prefer to see the head end system wherever it is practical to use it, and where it is not, to make your combinations, getting the best and cheapest results to the greatest extent possible. It at least gives us a data to turn to for comparisons, or for costs of the different types, and even though the figures may vary somewhat from the actual experience of some of us, they are reasonably uniform, I believe, in all three types. They do verify our own experience as far as cost is concerned, of the several systems, and while I have not had time to analyze the paper so as to make any comparison as to what our own figures show with these several types, yet I do know this, that they are in the same order that our figures show.

Mr. Gilman: In the matter of figures, I would say that our cost of maintenance has been considerably less than the figures given by Mr. Ott, but, as Mr. Manchester just said. I believe his figures are relatively very well taken and do show just about the relative cost between the different systems.

I thoroughly endorse his idea about the head end system. There are a number of difficulties to overcome in connection with the head end system, and the particular one is, what auxiliary shall we use with it? An auxiliary light is a necessity, and from our practice, although we have not done it entirely by storage batteries, I believe the best solution of it is an auxiliary storage battery on each car. This arrangement brings up a matter which is a very important one, i. e., the charging of the batteries on the trains as much as possible to avoid extensive charging stations at terminals. In the past it has been hard to get apparatus to do this work, and in a great many cases it necessitated an attendant of considerable ability and whom we had to pay a high salary to do this charging.

There is apparatus on the market, or at least to be had today, which will automatically charge storage batteries on trains and will do it without disturbing the efficiency of the lamps, and I think that is what we want. When that is perfected it will enable us to handle our head end system with good economy.

On our own road and on most other large ones there are a number of cars which several gentlemen have called attention to which cannot be handled except by an axle lighting device; they are what we call "special service" cars. They do not stand at terminals long enough to allow the batteries to be charged so that straight batteries can be used, and they are not in the head end lighted trains, so that there is nothing to fall back on but the axle lighting, and for that service it meets the requirements better than anything else. We must have batteries under our cars, as certain conditions make storage batteries a necessity; we are going to keep the end system for we know it gives the best service and we must have axle lighting to take care of special cases, so that we are bound to keep up the three systems of lighting. Perhaps some day there may be a storage battery brought out which will be indestructible, cheap and which we can charge whenever we can find it convenient. When such a battery is brought out, one-half of our troubles will be over.

To show you how reliable the head end system is, I will quote you some figures taken from our trains, giving the hours lights were out in regular service during the year 1906. I took the number of cars to which several gentlemen have called attention which lighting per year. On our train No. 2, Chicago to Omaha, the lights were out on that train during the year 95 hours and 15 minutes; on the Pioneer Limited, 21 hours and 30 minutes, and on the South West Limited 37 hours. This is really a very small percentage of "darkness," on account of various troubles and vexations of one kind or another which are bound to happen to trains.

While we are on this subject, there is a matter I would like to touch upon a moment, and that is, in regard to the efficiency of the lights we use in our cars. As you all know, in the last few years, cars have increased rapidly in size and the number of lamps has increased with them. Increasing our general lamp load until lighting satisfactorily from a storage battery is almost impossible.

In the last few months I have attended several meetngs in Chicago of the Illuminating Engineers, and it has occurred to me that if we could get a better type of lamp and more efficient fixtures and shades, that we could perhaps get better economy in our lighting and if not better economy, get better lighting service for the money we are now spending. The high efficiency lamp is on the market, and the Hollipham shade is also to be had and if used intelligently it is very effective. Now, it seems to me that it is up to us to apply these high efficiency lamps wherever we can, and also these shades, or possibly something equally good, and thereby improve

the lighting of our cars, and cut down the energy required. What, to my mind, is now before us is to join hands with the builders of cars, consult illuminating engineers and try to improve our methods of applying the lamps and to improve the fixtures themselves. We have a great many very handsome cars and there is no end to the variety of the lighting fixtures, but a great many of them are very inefficiently lighted and as a matter of fact, the lighting in general can be vastly improved and we can certainly improve the economy, so that, as I said before, we should get in closer touch in some way with the builders of cars and the designers of the fixtures.

In most of our cars we are using more current than we should; in fact, I think we are wasting a great deal of it, and I have some figures here giving the watts per square foot of floor area, for instance, in our own cars:

Dining car,	5.8
Sleeping car	4.8
Parlor car	4.4
Coach	2.8

In the March number of the "Illuminating Engineer" Mr. Kilner gives the watts per square foot of floor area to light a bank office as .89 with entirely satisfactory results. In the February number of the same paper Mr. Feiker gives the watts required per square foot in a department store as 2.02, and the photographs accompanying this article show that the lighting is very satisfactory.

Of course in illuminating cars more light is required than in general building lighting on account of the usually dark color of the woods and the furnishings, and perhaps the amount of energy we are using cannot be cut down. At the same time, I still believe there is quite a field for us to improve in that particular, and we ought to get facts from an illuminating engineer. I think if we could get such a man to speak before this body it will greatly interest us to find out what has been done within the last few years in this branch of engineering.

The Chairman: As the hour is getting late I will ask Mr. Ott to come forward and close the discussion.

Mr. Ott: Mr. Chairman, in regard to Mr. Gilman's comment on the 96 volt lamps, I would say that those were special lamps; that train is no longer running, and I would unhesitatingly recommend a 60-volt lamp for all storage battery cars.

In regard to the steam hose cost brought up by Mr. Farrelly, would say, that we use ordinary steam hose and displace these hose from the front end of the train to the rear end of the train where the steam pressure is lower at the end of every six weeks, or, if the indications show up badly, move them back at the end of the month so as to keep them from bursting. Then I would refer to the M. C. B. rule book for 1906. If you will note at the back of this book under passenger car interchange prices the price for a new 1½ inch

hose applied to the car is, $6.50, and the credit for returning the fittings of an inch and a half steam hose is $5.25. This gives us a net cost of $1.25 for renewing the hose. When a hose is replaced in this way you do not lose your coupling and your nipple and therefore there is no reason why Mr. Farrelly should be charged $5.25. I think the supply department must have it in for him.

In regard to the question brought up by Mr. Jansen on cost of train line,—the cost per car depends a great deal on the kind of wire and conduit in use. I know the figure of $130 is all right for the wire and conduit in use on the Burlington.

As to the cost prices quoted on axle generator sets being 15 to 20% high, the figure of $670.00 was derived by averaging the cost prices on three different makes.

The point brought up by Mr. Symons whether the battery current would succeed in running the dynamo as a motor unless cut off by the automatic circuit breaker of the axle dynamo,—I would say that unless the breaker did cut out, there would be a liability for some fireworks. I do not believe we would succeed in running it as a motor, because something would burn before that happened.

In regard to his comment on the length of time of the use of batteries in changing engines and cutting out the dining car,—the figure of 12 minutes quoted is conservative, of course. There are instances when the battery will have to carry the load for a considerably longer time, but I believe that that is a fair figure as to average practice.

In answer to Mr. Symons' question whether 8 pounds of coal for a horse power hour at the drawbar, is not high. I can say, a great deal depends on the kind of coal. With coal at $2.00 a ton I think that is very fair. I have some figures here that were taken from results of a long series of engine tests extending over about six months on a level division, and I will read the average coal per drawbar horse power:

For a simple ten wheeler having cylinders 19x28 inches the figure was 8.35 lbs. For a simple Atlantic type engine having cylinders 20½x26 inches the figure was 8.97 lbs. For a balanced compound Atlantic type engine with cylinders 15 and 25x26 inches a figure of 6.98 lbs. was attained. For another simple Atlantic type engine with cylinders 20x26 inches the average figure was 7.82 lbs.

I decided 8 pounds would be about fair with coal at that price. Of course when you can get Pittsburgh lump coal that has cost $3.00 f. o. b. Chicago you can probably get a higher evaporation and you can cut that figure down.

In regard to the suburban locomotive question, I believe Mr. Symons asked whether that extra locomotive fitted up for protection purposes would be available. Of course, a great deal would depend on your suburban service. On some roads where they have special engines for suburban service I do not believe there would

be any trouble at all about properly covering the regular equipment with the extra locomotive.

Mr. Farrelly comments on the number of lights per car. A great deal depends there on what your Passenger Department demands. If they want a generous amount of light, why, it is up to us to give it to them.

Right here I might say that one of the strong features of the head end system is that you are not tied down to a restricted number of lights per car and you can use all the 16 C. P. lamps you want. Additional coal at the locomotive will be the only added cost and with a 25 K. W. set as quoted for the sample trains this would be very small as the more nearly you approach the full rated load of your generator the lower will be your steam consumption per K. W. hour.

Regarding the cost of hauling the dead weight of the lighting equipment, with the figure of three mills per mile quoted from Mr. Deems, I do not believe that it is quite fair to charge up to the engineer, fireman, train crew, and the various terminal and maintenance charges that enter into that figure.

You have an eight-car train, say, and you want to light that train electrically; you add a head end equipment, storage batteries, or axle dynamos, but you do not as a rule increase the size of your locomotive. I think the only fair item to figure is the coal, the rest of the charges would remain unchanged anyway, whether you added the extra weight or not. You should consider only the changes made in a train after you light it. I do not believe that the comparison with a freight train will hold.

With a freight train one or two tons added dead weight per car would mean one or two cars less per train. On a passenger train, however, an addition of from 8 to 20 tons per train would hardly result in a lesser number of cars per train.

In regard to the question of the oil and waste bill; placing the generator crosswise of the car will bring the bearings out of level. whenever you hit a curve that is banked at all, or especially if you have to stop on a curve. We have had instances where the car stopped on a curve and the oil pump would succeed in wasting a great deal of oil around the car. The figures quoted are actual figures from our Kansas City trains. It takes as much oil to make the round trip on our Kansas City train as it does on the Denver train, and the time for the round trip is just half, two days in one case and four in the other, the generators on the Kansas City trains being placed crosswise while those on the Denver trains are lengthwise.

In regard to use of old batteries on private cars,—if you put those batteries on cars that run a long distance that arrangement could not be made, but where you use batteries on private cars just simply to run a couple of fans and probably a light or two for a

state room, I think that they would be satisfactory. Of course a great deal would depend on the official you are serving.

Regarding Mr. Gilman's remarks on experimenting along further lines to get less wattage per lamp and more efficient lamps, there are some experiments being conducted now on one of the suburban lines where they are lighting suburban coaches with three arc lamps. The object there was to get light with less watts per candle power. On another line they are trying Mercury Vapor lamps on a mail car. Those experiments are along the right direction. Perhaps some day we will have cars with Nernst lamps, and 250-volt circuits. I would like to see such a thing tried, and certainly think it would be of value.

In regard to Mr.. Barnum's remarks about the figures being conservatve, well, I think they are; I know they are conservative. So much depends on the kind of people you have to employ to handle your lighting systems as to keeping down the cost, that it would be hard to make an estimate that would cover all kinds of men. If you can only pay $2.50 a day for an electrician to handle axle dynamos, I am very positive the cost will run considerably higher. Another factor will be the number of equipments you are operating, the cost will not be as high on a road operating a large number of equipments as on another with only a few equipments and these perhaps scattered on widely separated runs.

The Chairman has very aptly compared the electric lighting situation to the heating of trains by Baker heaters and straight steam, noting the necessity for lighting cars in stations and at terminals after the locomotive has been released, and comparing this situation to the use of Baker heaters for heating cars under similar circumstances where steam is not available. As is stated in the paper I fully believe that each system of lighting has its field and that we could not very well dispense with any of them. However, I believe with Mr. Manchester that the head end system is bound to come into more extended use. As now most of the large roads have the majority of their passenger locomotives fitted up for straight steam heating, perhaps in the near future these same locomotives will each carry a turbo-generator set which will displace the present electric head light sets, which are now quite common, and thus light the train from the head light to the tail lamps with current made with steam from the locomotive boiler.

Mr. Symons: The Club is very fortunate in being favored by this valuable paper by Mr. Ott, and particularly his closing remarks wherein he has explained the points raised, and I therefore move that a vote of thanks be extended to Mr. Ott for his interesting paper.

The Chairman: You have heard the motion; all in favor will please say "Aye."

Motion carried.

ADJOURNED.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium May 21, 1907. President H. T. Bentley in the chair. The meeting was called to order by the President at 8 P. M.

PRESIDENT BENTLEY: The meeting will please come to order. The first order of business is the approval of the minutes of the last meeting. As these have been printed and distributed, unless there is any objection they will be approved as printed. The Secretary will now make his usual report.

THE SECRETARY: Mr. President, I have the usual membership report:

Membership, April, 1906		1,386
Resigned	15	
Dead	1	16
		1370
New members approved by Board of Directors		30
Total membership		1,400

NEW MEMBERS.

NAME ADDRESS	PROPOSED BY
E. B. Hughes, Mech. Dept. Wabash. R. R., Paterson, N. J.	B. H. Jeffries.
J. T. Markham, Sellers' Mfg. Co., Chicago	E. M. Kerwin.
H. J. Green, Chicago Varnish Co., Chicago	O. H. Morgan.
G. N. Saum, Car Foreman, C. & W. I. R. R., Chicago	P. H. Peck.
H. J. Kessler, Draftsman C. B. & Q. Ry., Lincoln, Neb.	Thos. O'Neal.
W. F. Hall, Spec. App. L. S. & M. S. Ry., Collinwood, O.	I. S. Downing.
R. C. Raines, R H. F. Norfolk & Western Ry., Williamson, W. Va.	D. G. Cunningham.
H. E. Dickerman, Yale & Towne Mfg. Co., New York City	G. A. Stone.
P. M. La Bach, Draftsman, C. R. I. & P. Ry., Chicago	A. K. Shurtleff.
J. J. Barry, G. F. N. & W. Ry., Roanoke, Va.	D. G. Cunningham.
C. E. Thomas, G. F. Ill. Central R. R., Chicago	J. W. Motherwell.

NAME	ADDRESS	PROPOSED BY
E. J. Buckbee, Mach. Foreman C. C. C. & St. L. Ry., Urbana, Ill.		J. C. Thorpe.
LeRoy S. Wright, Salesman Natl. Mall. Castgs. Co., Chicago, Ill.		J. H. Jaschka.
G. H. Davison, 2nd V. P. Beckwith-Chandler Co., New York		W. L. Crossman.
W. T. McKee, Piece Work Insp. L. S. & M. S. Ry., Collinwood, Ohio.		I. S. Downing.
D. E. Gardner, R. F. E. Norfolk & Western Ry., Portsmouth ,Ohio.		D. G. Cunningham.
J. A. Baldwin, Repr. Berlin Mach. Wks., Chicago, Ill.		Thos. Plunkett.
W. E. Wunderlick, Eng. House Foreman Penna. Co., Chicago, Ill.		W. E. Sharp.
H. E. Tucker, N. Y. Air Brake Co., Chicago, Ill.		J. W. Taylor.
Christopher Day, Car Foreman So. Side Elevated Ry.		G. H. Hopkins.
Thos. C. Eayrs, Engr. Westinghouse E. & M. Co., Chicago, Ill.		G. H. Hopkins.
G. W. Hanaur, Supt. C. I. & S. Ry., Hammond, Ind.		W. E. Sharp.
F. G. Colwell, Shop Foreman I. C. R. R., Chicago		G. M. Crownover.
G. D. Bassett, Crerar Adams & Co., Austin, Ill.		H. T. Bentley.
C. E. Mohle, Specialist C. & N. W. Ry., Oak Park, Ill.		H. T. Bentley.
W. P. Steele, American Loco. Co., New York		C. A. Seley.
Edgar Lewis, Westinghouse Mach. Co., Chicago		A. B. Johnson.
W. M. Perry, Elect. C. & W. I. R. R., Chicago		P. W. Pick.
R. W. Rustuholz, Ingersoll Rand Drill Co., Chicago		L. E. Ensley.
Geo. Cooper, Frost Ry. Supply Co., Detroit		C. A. Seley.

Resignations.

W. D. Sargent, Amer. Brake Shoe & Fdy. Co., New York. Unable to attend meetings.
J. F. Ryan, N. Y. C. & St. L. R. R., Chicago. Other business.
E. D. Edgerton, Care C. R. I. & P. Ry., New York. Located in New York.
E. G. Busse, Care Illinois Central R. R., Chicago. Unable to attend meetings.
H. A. Fergusson, Care J. T. Ryerson & Son, St. Louis. Located in St. Louis.
W. H. Corbett, T. M. Mich. Central R. R., Jackson, Mich. Unable to attend meetings.
Thos. Jackson, Care Mech. Rubber Co., Redlands, Cal. Unable to attend meetings.
R. H. Soule, Boston, Mass. Unable to attend meetings.
G. M. Nisbett, Chicago. Not in railroad supply business.
J. F. Fleischer, M. M. C. & N. W. Ry., Sioux City, Ia. Unable to atttend meetings.
W. H. Stare, Advance Construction Co., Waukesha, Wis. Out of railroad business.
E. L. Burdick, Insp. Tests Wabash R. R., Springfield, Ill. Unable to attend meetings.
C. W. Spencer, Can. Pac. Ry., Montreal, Can. Unable to attend meetings.
B. H. Hawkins, Gold Car Heating Co., New York. Unable to attend meetings.
H. C. Pearce, G. S. K. So. Pac. Co., San Francisco. Unable to attend meetings.

Dead.

J. P. Brown, Loco. Engr. C. N. O. & T. P. Ry., Somerset, Ky. Died Feby., 1906.

The Secretary: I might say under the heading of New Business that this being the annual meeting, at the meeting of the Board of Directors this evening the following committee was appointed to audit the books of the Secretary and Treasurer: T. H. Goodnow, O. M. Stimson, and H. La Rue.

Those are all the reports I have, Mr. President.

President Bentley: Before starting the regular business of the evening, gentlemen, I want to draw your attention to the menu that our worthy Secretary has prepared for our delectation; in fact, he has timed everything to the minute so that there may be no delay in our carrying this out; unfortunately we were thirty seconds late in starting, so that we will try to make that time up.

The first regular paper of the meeting to-night is the report of the Committee on "Delay in Movement of Empty Cars at Terminals." As the Chairman of that Committee, Mr. Buker, is not here, the Secretary will read excerpts from it.

The Secretary: I see Mr. Manchester and Mr. La Rue are here; probably they would prefer to read it.

Mr. Manchester: Go ahead.

The Secretary: I do not think there is any use in reading the paper, because it was read last month and was sent out this month as an advance paper, so that the members have probably read the paper. If you will turn to page 6 of the Report of the Committee, I will read from there. The complete report is as follows:

REPORT OF THE SPECIAL COMMITTEE APPOINTED TO CONSIDER THE QUESTION OF DELAYS IN THE MOVEMENT OF EMPTY CARS AT TERMINALS.

To the Members of the Western Railway Club:

At the meeting of the Western Railway Club held at the Auditorium Hotel on April 16th, 1907, Mr. W. E. Beecham, Car Accountant of the C. M. & St. P. Ry., presented a paper as follows:

DELAY IN MOVEMENT OF EMPTY CARS AT TERMINALS.

Mr. W. E. Beecham, Car Acct., C., M. & St. P. Ry.

For some time past I have been looking for an opportunity to attract the attention of the railroads centering in Chicago to the manner in which empty foreign cars are sometimes, so to speak, thrown in the air between them, and I am inclined to the belief that this is the right time and place to begin a crusade of that kind, and I will be glad if there is a representative present in this assembly from the Car and Operating departments of every railroad centering in Chicago to hear what I have to say on this subject and, if I

should succeed in arousing so strong a sentiment against this practice that its complete and final suppression follows as the logical result of the discussion which I hope to provoke on this occasion, I shall consider myself amply repaid for the effort.

At the outset I wish most emphatically to record my belief that the practice referred to has no warrant for existence and that, in my judgment, it is not only inimical to the interests of every railroad centering in Chicago, but it is besides a positive injustice to car owners.

I shall make no attempt to fix the responsibility for this state of affairs in the interchange of cars between the roads centering here, because that would be useless and perhaps impossible, and, besides, it would do no good. What is needed is a remedy for the difficulty and if one is found it must be obtained through the co-operation of all the lines in interest, and, in order to place the matter before you in its proper light, it will be necessary to furnish some evidence of the existence of the practice to which I allude.

In doing this, direct reference must necessarily be made to the railroads directly involved, but that does not imply a desire on my part to make invidious comment likely to provoke an accrimonious discussion. Direct reference is only made to enable me to place the question before the assembly in an intelligent manner and to strengthen my argument against the continuance of a practice which I feel assured you will all say has none of the elements of a business proposition and is therefore not good railroading.

If the Master Car Builder's Rules of interchange and the rules adopted by the Car Foreman's Association of Chicago were observed, such movements as are here specifically cited would never occur, because those rules are fully qualified to provide for all cases arising from disagreements of inspectors over the condition of cars. and if the rules of the General Superintendent's Association of Chicago were observed, they would be infrequent, because those rules are sufficient to insure proper handling of cars under most circumstances.

It is apparent then that we don't need any more rules or agreements to meet the situation and that a failure to observe the rules and agreements now in effect is the cause of the trouble. I am satisfied that very few railroad officials know to what an alarming extent the mishandling of cars in a large terminal is carried, for the reason that it is impossible to compile comprehensive statistics necessary to make a showing. It goes on from day to day, year in and out, but I am of the opinion if it were practicable to show all the unnecessary movements which empty cars make in a large terminal like Chicago and the amount of time, money and energy wasted in consequence, it would astonish the most skeptical. Many causes combine in forcing empty cars to make a great many useless and unnecessary movements in all large terminals, but for my purpose it will only be necessary to mention a few of them.

Errors on the part of yard forces cause many cars, loaded and empty, to go wrong, and I presume we shall never be able to entirely overcome that, but such errors should be reduced to an insignificant minimum and so they will be if due care and diligence is exercised in handling cars. By carefully training and educating employes to take a personal interest in the economical conduct of affairs, we can gradually lead them to a proper understanding of the importance of doing things well and, so far as possible, avoiding false movements in handling cars. They should always be sure to get the proper destination of a car and then see that it is properly started on its way.

Switchmen should be urged to report in every case where they have been required to handle cars unnecessarily, in order that steps may be taken to avoid re-occurrence.

Disagreements and disputes between inspectors as to responsibility for defects existing in cars cause them to make more unnecessary movements empty than any other known cause and my experience is that investigations are generally barren of results. Why this should be I am not in position to say; I only know that it is so, and so far as I can see there is no excuse for it. At the same time, I admit I am not qualified, by practical experience, to judge of the merits of a case involving mechanical points and, for the same reason, it is difficult for me to present the question to you in all its various aspects. I could not determine the mechanical merits of any case, even if I had the exact condition of all the cars I shall refer to, because I am not a car builder, but there is one thing I do feel pretty sure about and that is that the mechanical departments are largely at fault for conditions tending to wastefulness and contributing to bad work in a terminal where there is neither room nor time to spare, and it is to that department, without bias of any kind, that I desire most particularly at this time to address myself.

If it were not customary, and necessary as well, to interchange cars in bad order, it would be easy to find a remedy for the difficulty referred to by making an agreement that delivering lines must invariably see to it that all cars offered in interchange shall be put in good order beforehand, but such a restriction would hamper and retard the movement of traffic in a most vexatious manner, moreover, it would nullify, if not entirely destroy, one of the wisest provisions of Master Car Builder's rules. A great many cars cannot be repaired under load, and, as transfers fall on receiving lines in Chicago, such cars are delivered to connections, shipments transferred and cars returned, and here is where the trouble begins.

It frequently happens that existing defects are augmented by the switching and when such a car is returned to the delivering line it is rejected by the inspector and, without any attempt being made to adjust matters the car is immediately sent back; then commences

the shuttle-cock process and before the case of such a car is settled it may make many movements between two railroads, because one does not want it and the other won't have it—all the while piling up trackage and per diem for the juggling roads to pay and depriving the owner of the use of his car besides.

The interchange of cars between the St. Paul and most of its connections in this terminal is through the Belt lines. The charge for moving an empty car is a dollar one way and, in addition, a reclaim of twenty-five cents is allowed for the intermediate move, making the charge to the delivering line $1.25 to $2.50 for the round trip. I have a number of cars that have made unnecessary movements between the St. Paul company and its connections, and if you will follow me I will endeavor to show you what these unnecessary movements entail in the way of expense.

D. L. & W. car 23060 made four round trips empty between the St. Paul and the N. Y. C. & St. L. roads between February 17, and April 15, at an expense for trackage and per diem of $40.00 before its case was finally settled. In this case candor compels me to admit that the evidence is very much against our own people, but that is not going to deter me from making an open confession and stating the facts. This car was delivered to us under load and in good order, it is claimed, and we returned it with two center sills and one inner sill broken, making a combination of defects. The N. Y., C. & St. L. refused to receive it and our Chief Inspector went to Stony Island and saw Mr. James, Master Mechanic, N. Y., C. & St. L. Ry., about the car. The next day a letter was received from Mr. James saying he would accept the car on the following conditions, namely, that the car shall carry home route cards and that the two center sills be planked in proper shape so that the car will be safe to handle in trains to Buffalo. Also, that defects on car must be fully covered by our Master Car Builder's defect card. Admitting, for the sake of argument, our defenseless position in sending an empty car to a connecting line in such a condition, let me ask first, why should a delivering line be called upon for a home route card for a car that was entitled to return via the Nickle Plate to the owner, one of its direct connections, and second, why did the Nickle Plate not repair the car, load it to Buffalo, or in that direction, and call upon us for defect cards covering our responsibility, according to Rule 8 of the Car Foreman's Code?

These questions are not asked with a view of letting the St. Paul down as easily as possible, or for the purpose of showing that the Nickle Plate is to blame. Here is a 60 M capacity box car out of service for sixty days while two roads juggle it between them empty and pay $40 for the privilege.

G. S. & F. Ventilated Fruit car 2363 was received from the I. C. via the Chicago Belt February 23, loaded for Milwaukee, and when made empty it was returned to our Galewood yard where it arrived

March 1st and on March 2nd it was returned to the I. C. via the Belt. This car also made four round trips via the Belt between the I. C. and our line and was last returned to us March 26, and is in our yard at this writing.

Per diem and trackage accumulated on this car to the amount of $32.50. This makes a total of $72.50 for three roads to pay for the privilege of juggling two empty foreign cars between them, which I think you will admit is equivalent to throwing so much money away.

These two instances are of themselves sufficient to fully illuminate the point I am trying to make and I am satisfied that it is only necessary to draw attention to this matter to fully impress upon the minds of all concerned the importance of taking immediate action to put a stop to such wastefulness.

I am not able to furnish much information in regard to the last mentioned car. Our Chief Inspector, Mr. William, went to see General Foreman Dare of the I. C. and he reported that Mr. Dare said the car was not rejected by his inspectors, although it was in bad order, but Superintendent of Transportation Keith, of the same road, wrote to me that it *was* rejected by his inspectors and he further stated that his company will not accept cars in bad order unless fully carded for defects. At the same time, Rule No. 8 of the Car Foreman's Association does not require that cars should be so carded. That rule reads as follows:

"It is understood that in the interchange of cars within the Chicago Switching District all parties to this agreement will accept as their own the record of the receiving line, so far as the condition of the car is concerned, and that M. C. B. Defect Cards will be furnished for such defects when proper request is made, when based on M. C. B. rules and this agreement."

The Master Car Builder's Rules provide that cars offered in interchange must be accepted if in safe and serviceable condition, the receiving line to be the judge in cases not provided for in Rules 3 to 56 inclusive and in the declaration of principles the Master Car Builder's Rules must positively affirm that "These rules make car owners responsible for, and therefore chargeable with, all repairs to their cars necessitated by ordinary wear and tear in fair service, so that defect cards will not be required for any defects thus arising."

One thing is made clear to my mind at least by this exhibit, which is that there is a wide difference of opinion among employes of the Car Department regarding the intent and purport of the M. C. B. Rules of interchange and the subsidiary rules of the Car Foreman's Association, otherwise empty cars would not make such movements as have been cited.

This may be due in great measure to the failure of those whose duty it is to properly instruct inspectors respecting their duties and in part to a mistaken idea that it is the duty of an inspector to get

ahead of others by employing sharp practices if necessary. There is a cause for every effect and as we know what the effect is in this case, we ought to find the cause and a remedy for it.

Inasmuch as I have arraigned this practice and have no hesitation in saying that I cannot command language too strong in condemnation of it, I presume you will expect me to suggest a remedy, but I am not fully prepared to do that at this moment. However, I will make one or two suggestions:

When an empty car, foreign to your road and to the delivering line, is received in bad order, don't let your inspectors fire it back on the next transfer without calling the attention of the Chief Inspector to it and don't send it back then until you have notified the Chief Inspector of the delivering line of your intention to do so and given him the reasons for that course. Then see to it that all cards of very kind are stripped from the car and that your cards are put on both sides, plainly indicating that the car is being returned on account of being in bad order and, in addition, bill it to Mr. Blank, Chief Inspector of Blank Railroad, and show on billing defects which you object to. Take every legitimate means at hand to protect your company from imposition, but remember that the mutual interests of the railroads centering in a common terminal are entitled to great consideration at your hands and that all lines should work as one for the common good, when they can do so without detriment to their own interests.

Try to impress upon the minds of the inspectors this important fact, namely, that every time you move a car it costs money which somebody must pay and that unnecessary movements must be avoided.

Every road in Chicago has a way of protecting itself if it finds other lines are acting unfairly in the matter of giving it empty cars in bad order. It can return a car and charge the delivering line one-half the regular rate, $2.50, and in addition to that, the reclaim for three days per diem and, in addition to that it can insist that Belt Line charges shall be assessed against the line at fault. So you see it is possible to make it expensive for any line guilty of unfairness.

Misunderstandings, mistakes and unintentional failures to observe ordinary care cause most of the troubles we complain of. These difficulties can all be met and successfully overcome if we all join hands together in well directed efforts to conserve the common good and with a view of taking some action to-night to bring about a result so much to be desired: I will offer a motion that the subject of this paper be referred to a committee of three, to be appointed by the Chair, to investigate and report its findings and make recommendations to the next meeting of this club.

On motion duly seconded the following committee was appointed to consider the points brought out in this paper and report back to the club at its May meeting.

Subsequently the Chairman appointed the following committee:

J. E. Buker, A. S. M., Ill. Cent. R. R. (Chairman).
C. W. Kouns, S. T., A. T. & S. F. Ry.
F. M. Luce, Auditor Car Accts., C. & N. W. Ry.
A. E. Manchester, S. M. P., C. M. & St. P. Ry.
H. LaRue, M. C. B., C. R. I. & P. Ry.

Committee.

At the call of the Chairman a meeting of the committee was held in the office of the Secretary of the M. C. B. Ass'n, 390 Old Colony Building, Chicago, on May 7th, 1907, at 10 o'clock A. M., the following members of the committee being present or represented: J. E. Buker (Chairman), represented by Mr. Gottschalk; H. LaRue, represented by Mr. Godfrey; F. M. Luce, A. E. Manchester; Mr. Beecham, author of the paper; Mr. T. R. Morse, C. F. C. D., C. M. & St. P. Ry., and Mr. J. W Taylor, Secretary of the Western Railway Club. Mr. Kouns was not present.

Mr. Gottschalk was named as Chairman of the meeting, and Mr. Taylor, Secretary.

The subject matter of the paper was thoroughly discussed from all angles, and it is the opinion of the committee that the delay in the interchange of empty cars is not attributable to any one department; it seems to be due to a lack of familiarity with the rules on the part of all the different classes of railway men who have to do with the handling and movement of cars, i. e., the car department forces, car accountants' forces, the agents' forces, consisting of the yard clerks (who, in the opinion of the committee, seem to be the most interested), and the yard switching forces.

It is the opinion of the committee that the fault lies largely with the yard clerks, who, without thorough investigation, order cars from one yard to another when they should not be moved. Another cause, and it seems to be one of the principal causes for unnecessary movement of cars, is that cars are not returned from one road to another via the route over which they were orignally interchanged, so that the local records of the cars are not at the point where delivery is trying to be made. Another cause is the abuse of the home route card in the handling of cars routed home on account of being in unsafe condition to load.

Another source of delay is that cited in the paper above, i. e., that when a car is offered in interchange and rejected by the receiving company for defects or other causes, the car immediately begins a shuttle-cock movement back and forth in an endeavor to locate responsibility for repairs or other causes, with the result that where

there is an intervening or switching road the per diem piles up while the car is virtually out of service and its earning capacity nil.

A copy of the rules governing the interchange of cars within the Chicago Switching district as adopted by the Car Foremen's Association and approved by the General Superintendents' Association, was introduced and is given below as a part of this report because of the important bearing it has on the question under discussion.

RULES GOVERNING INTERCHANGE OF CARS WITHIN THE CHICAGO SWITCHING DISTRICT, AS ADOPTED BY THE RAILWAY CAR FOREMEN'S CLUB AND APPROVED BY THE GENERAL SUPERINTENDENTS' ASSOCIATION.

Rule 1. Cars with defective safetly appliances constituting a violation of the Law, must not be offered in interchange.

Rule 2. Empty cars that are to be sent to a connecting line, on an order, must be inspected and put in a serviceable condition before delivery is made.

Rule 3. Loaded cars offered in interchange must be accepted, with the following exceptions:

A. Cars that cannot be safely handled.

B. Defects constituting a violation of the law.

C. Leaky tanks.

In case of loaded cars consigned to the switching district, it is agreed that any company delivering a car to any party signatory to this agreement, will accept the same back again with a defect card covering additional defects, provided such defects form a combination.

Rule 4. If a road agrees to accept a foreign car that was not delivered at the interchange point, the delivering company shall put such car in serviceable condition.

Rule 5. Foreign cars delivered to connecting lines and made bad order while on such lines, must be received back by the delivering company,, unless the cars are in a general wornout or wrecked condition, as outlined in M. C. B. Rules Nos. 125 and 126.

Rule 6. In case of a car being delivered to connecting line to which it does not belong, the party responsible for such wrong delivery will be held liable for any damage that may occur as the result of the defects that existed at time of wrong delivery, provided such defects form a combination.

Rule 7. It shall be the duty of the transportation department to notify the car department of any movements of cars governed by Rules Nos. 2, 5 and 6.

Rule 8. It is understood that in the interchange of cars within the Chicago Switching District, the parties to this agreement will

accept, as their own, the record of the receiving line, so far as the condition of the car is concerned and that M. C. B. defect cards will be furnished for such defects when proper request is made. if based upon M. C. B. Rules and this agreement.

Rule 9. An Arbitration Committee of five members shall be appointed by the General Superintendents' Association, consisting of two members of the General Superintendents' Association and three members of the Car Foremen's Club, to which Committee shall be referred all disputes arising under this agreement. Decisions of this Committee shall be final and binding. Three members shall constitute a quorum.

Rule 10. These rules shall become effective upon approval of General Superintendents' Association. They may be amended at any regular or special meeting of the Board of Directors of the Car Foremen's Club, said amendments to become operative only upon approval of the General Superintendents' Association.

Arbitration Committee—General Superintendents' Association: C. B. & Q. Ry., H. D. Judson; Erie R. R., J. P. Sherwin. Car Foremen's Club: Penna. Lines, F. C. Kroff; C. M. & St. P. Ry., T. R. Morris; L. S. & M. S. Ry., I. S. Downing.

Investigation develops the fact that these rules are not enforced; that in many instances the men handling cars have not been furnished with, nor are acquainted with them.

After a thorough consideration of these matters your committee is of the opinion that it is not lack of necessary rules and regulations for the handling of this traffic, but a lack of enforcement of the rules now in effect, and it would recommend:

First. That the General Superintendents' Association strictly enforce the code of rules given above, which was prepared by the Car Foremen's Association and approved by their Association.

Second. That all car inspectors, car clerks, car accountants, yard clerks and every person who has to do with the handling of cars in the Chicago switching district be furnished with a copy of these rules, and instructed that the provisions of same must be strictly complied with.

Third. It is also suggested that the provison of these rules governing the matter of settlement of disputes be enforced, as it is felt that the settlement of a few specific cases by arbitration will have the effect of straightening out a good many causes for delay in the handling of traffic.

Fourth. It is also recommended that the authority for all reverse car movements should be centered in the hands of one person on each road, so that such movements will not be made until arrangements have been perfected with the proper parties and all interested advised of the proposed reverse movement.

Your committee is firmly of the opinion that a great improvement in the prompt handling of traffic in the Chicago switching district

will result from the enforcement of the above rules and recommendations and would earnestly request the co-operation of the General Superintendents' Association in the strict application of the rules they have already approved.

Respectfully submitted,

Jos. E. Buker, *Chairman.*
F. M. Luce.
C. W. Kouns.
A. E. Manchester.
H. LaRue.

Committee.

President Bentley: Gentlemen, you have heard the report of the Committee on this very important subject. I did not know, I had no idea, in fact, how it was possible to keep a car moving so much and do nothing. The matter seemed of such importance to me that I wrote letters to our General Superintendent, our Superintendent of Terminals, the Car Service Agent and our worthy Superintendent of Car Department, asking them if they could possibly attend here to-night and hear how some of the cars were moved back and forth without going anywhere. I notice Mr. Schroyer is here and we would like to have him open the discussion, or possibly Mr. Betts.

Mr. C. A. Schroyer (C. & N. W. Ry.): This paper has been prepared by Mr. Beecham, of the Chicago, Milwaukee & St. Paul, as Car Service man, and believing as I do that one car service man is just about as bad as another and a little worse, and inasmuch as there has not been enough in this paper to stir up the ire of the Car Service man, I think it would be wise to hear a little more from the Car Service men. My friend, Mr. Beecham, has been led to believe that this is epidemic; I do not believe that this is epidemic. I would like to know from some of the other Car Service Agents whether it is or not. I would like to have the Chairman call on Mr. Betts, of the Northwestern Railroad, he is a car service agent.

President Bentley: The President did call on Mr. Betts but Mr. Schroyer seemed to have something on his mind that he wanted to get off, so that Mr. Betts did not have a chance to get up.

Mr. E. E. Betts (C. & N. W. Ry.): I find it is a very hard matter for anybody to get ahead of the Car Department. I am glad, however, that the word "car" also prefixes my position on the Northwestern Road; it is not Car Department, it is Car Service.

I must say that I agree somewhat with Mr. Schroyer in the fact that this is not epidemic; however, there have been numerous cases that have come to my personal observation where a car has made even worse movements than those cited in the paper prepared by

my friend, Mr. Beecham, and no matter whether it is epidemic or whether it occurs spasmodically, it certainly does not tend to increase the efficiency of transportation in this country.

It certainly, in my judgment, is unfortunate that cars should make a movement of this character. I have had before me in the last two days cases where cars have lain dormant in a yard for thirty-four days, owing to some dispute of this character, and it seems to me that we ought to get together in a matter of this kind and apply ordinary common sense and stop these unnecessary movements.

I am not thoroughly acquainted with the M. C. B. rules at issue in this matter, but it occurs to me that it is more economical to effect these repairs after the car has been delivered to a connecting line, than to incur the expense of returning the car to the other fellow, which is unnecessary and delays not only the freight, but also the car, and a large number of cars delayed in this manner means an unneccessary delay in transportation, and we will admit that cars are sorely needed at the present time.

I think, however, that in any event if any cars can not be repaired after they are delivered, that before any car is returned to the delivering line, either on account of being in bad order, or by reason of the fact that the car has been erroneously delivered to the wrong road, that before this car is returned to the delivering line, some special arrangement should be made whereby the other fellow, when he gets it back, knows why it is returned, and will apply the necessary remedy before starting it in the other direction.

President Bentley: Is Mr. R. H. Johnson in the room? The reason I call on Mr. Johnson is because he is the man that does the pushing; he is pulling and pushing all the time from one road to another, and I thought probably he could throw some light on the subject.

Mr. R. H. Johnson (C. & N. W. Ry.): Mr. Chairman and Gentlemen—I am very glad to meet you. I do not know why you pick on the Northwestern in the beginning—why you do not give some of the other fellows a chance to say something before you find out what we know on the Northwestern.

I want to say that I think Mr. Beecham has made some very good points in his paper relative to the question of the return of cars and having one individual on the different railroads who knows when and where and how to check up the proper return of a car.

Recently we had a case, while interchanging with the Nickel Plate Railroad through the Belt temporarily, of a car being delivered to that road by way of Wood Street from our line, returned to us from the Nickel Plate by way of the Belt Line, sent back to the Nickel Plate by way of the St. Charles Air Line and again returned to us from the Nickel Plate by way of the Belt Railway and

kept going around the circle from our line to the Nickel Plate and from the Nickel-Plate to our line three round trips. These are very important and very expensive matters and on the Northwestern Railway we have, in our Terminals, what we call an embargo clerk and we try to curtail to the lowest possible minimum the number of cars that we will hold in our terminal for any certain consignee, firm or industry; and we keep our accumulations of cars cut down just as low as possible.

The question of inspection and return of cars having defective safety appliances, seems to me, is a subject of vast importance. I am thoroughly familiar with the M. C. B. rules governing this interchange of cars in the Chicago District; there are some very very good points in those rules and I believe, if they were strictly complied with by the yard and car department forces, a great deal of unnecessary movement and delay of cars would be eliminated. I believe that the yard master, indiscriminately, should not be allowed to return cars without taking the matter up with the proper official to ascertain whether or not the cars should be returned. For instance, some eastern line might deliver the Northwestern road a car in error, and, instead of returning that car to the delivering line, the Northwestern road should deliver it direct to the road it should go, at the expense of the delivering line; or, a car coming to the Northwestern road from the Fort Wayne, intended for the St. Paul road and coming to the Northwestern in error, it seems to me that the Northwestern road should, at the request of the Fort Wayne road, deliver that car direct to the C., M. & St. P. In this way, a great many cases of delayed freight and delayed cars would be eliminated.

There are a great many very important points in this subject, Mr. Chairman, that I could talk on at length, but would be pleased to hear some of the other gentlemen speak their views.

President Bentley: I think Mr. Johnson is correct when he says the rules are all right if they are only carried out properly. There is one road that runs into Chicago that handles a lot of switching business; they do carry out the rules with absolute correctness and that is the only road I know of that does, and Mr. Peck will explain how it is done.

P. H. Peck (C. & W. I. R. R.): Well, I was going to say something about the rules; you have too many rules. I am well acquainted with Mr. Johnson; he is a "buffing post;" you run the car into him and it stays put until it comes back again.

There is nothing in the recommendation in Section 4 that amounts to anything; as it is now, everybody returns the cars. Yard clerks, yard masters, agents, train masters go to the fountain head, but if he is not in, there should be some one to whom they can go. In certain cases I have been three weeks trying to get at the fountain head.

Another trouble I find in Chicago is, we do not have enough tele-

phone connections. This question was recommended several years ago. Mr. Barr, of the St. Paul, was chairman of the committee that recommended that we should have telephone connection over the different lines to the different car foremen's offices, etc.; they investigated and found it would cost about eight or nine thousand dollars; they did not put it in and it is not in yet.

The report of the Committee is all right and shows that the rules should be enforced. That is something that has not been done heretofore but is being done more and more every day. I am in a position to feel the effect of all that is done, but to my mind the only thing that will produce better results is to put the authority to regulate car movements in the hands of one man. Heretofore every one has had the authority to move a car and that is what Mr. Beecham is complaining about. The extra moves which he mentions, upon investigation were found to have been caused by the transportation department and not the car department. By the mechanical and transportation men getting together on this, they can call the attention of the other to the errors made by them and by so doing, correct them. I will cite one instance where the mechanical men were to blame; L. S. & M. S. car No. 30628 was received by the Belt Road from the L. S. & M. S. February 24, '07, on an order to Belt elevator for load. This car was loaded February 25, and delivered to the Lake Shore same day and was refused account of non-air. This is purely the fault of the mechanical department to refuse their own car after sending it on an order. No doubt the heads of the department did not know anything about this, however, and I knew nothing of it for some time.

All of our rules, both the M. C. B. and the Superintendent's are based on the inspection and the taking of many records. With the volume of business now in Chicago the roads should discontinue taking records of cars and put in practice what I termed last year at the Car Inspectors' Association meeting, "20th Century Inspection." By this, I mean to take no records of cars—inspect them for safety only and if a car is safe to run, take it—if not safe, make it safe or refuse it. Have no records of any cars excepting those that have combinations of defects that delivering companies are responsible for. With the system in vogue at the present time it takes fully five minutes to give a car inspection and make a record in the office. With the system outlined above, three or four minutes per car could be saved and this on a train of say 60 cars would mean 180 minutes or 3 hours, time enough to switch a train and deliver it at a reasonable distance and make room for more cars. Another thing to be considered is the ground covered by a train held up for inspection. About 15 tracks of 14 feet center and about five car lengths long cover an acre and will hold about 75 or 80 cars so it does not take long to cover an acre. In some places in this city the ground is worth from $20 to $30 per foot. An ordinary car 38 feet long with 14 feet center at $10 per foot covers ground worth $532.00 and it may be held a day or two for

some trifling defect. Many trains of cars go out of the city to outside yards that have as high as 85 cars in them: this means a solid acre of ground covered by this train whenever it stops. By adopting the above method the ground would be cleared much quicker and cheaper because it would save the unnecessary work of taking long records and unnecessary billing and the per diem. A request for a card now has to go through five or six different offices no matter how small the amount, and sometimes the labor and the holding of the car to get records costs more than the cost of repairs. Many times cards are asked for when none are due. To illustrate, suppose we receive a request from the Erie for a card; that is one letter. We ask our car accountant for the movement of the car, that is two letters; the car accountant furnishes moves, three letters; we look up the records and ask the C. & N. W. for card is four letters; they trace the car through their car accountant's office for moves and after getting them find that the car was received with the same defects at Wood street and so notify us, making all in all seven letters that have been written regarding this request for a card when there was none due. After that we notify the Erie that the car was received in the same condition at Wood street from them. With the system I have mentioned above these seven letters would be avoided. I will state for the information of the club that we have about 300 such cases per week at our fifty interchange points. Some roads have two, three and even four interchange points on our line and if a car is delivered at either of these points and a card asked for, it has to go through the same course as the one I have just mentioned.

President Bentley: When I called on Mr. Peck I thought he was not going to say anything; I thought he did not have any trouble. Well, gentlemen, it certainly is a very serious matter, this prompt moving of cars, and I think the point Mr. Peck has brought out about the value of the land is something that a good many of us do not consider at all. There are a great many gentlemen here whom we would like to hear from.

Mr. F. L. Richmond (C. & E. I. R. R.): I come from an isolated place in Indiana, representing the Chicago & Eastern Illinois, In reference to the gentlemen's talk about the delay of cars at terminals, I would say as to the yard masters, if there are any here, in regard to delays to foreign cars, I take it up with the foreman in charge of the engines. For instance, if a foreign car is placed for loading, say any time after seven o'clock this morning and he does not take the car away—if the car is brought in empty and he does not take the car out and deliver it to the foreign connection, I hold him responsible for the movement of that car and he has a demerit mark or a suspension, as the case may be, and I find that works successfully. Take it on the Indiana division last month, I do not believe we had an unaccounted car on the division. Our foreign cars,

were all accounted for. I believe that is the most successful way to enable us to relieve the service.

Mr. Schroyer: Mr. President, I would like to say a word, and I do not believe that this committe has touched the real point. I believe that the whole difficulty is due to the fact that in Chicago we have to do our business through Belt lines. Now, the Belt Line does not share in the full benefits of the Master Car Builders, rules of interchange, which were adopted to protect the roads in the interchange of their cars and the repairs of the same while they were away from home. They would not allow the Belt Line to make certain repairs to cars and take such advantage as they will of the railroads, because among the railroads it is a matter of reciprocity, while between the Belt Line and the railroads there is no reciprocity.

The whole question of the movement of cars in and about the City of Chicago is due to the fact that the Belt Line will receive from any of their connections a car in almost any condition it may happen to be and without any prejudice on their part to the delivering road will deliver it to the Chicago & Northwestern Railroad twenty miles away. We make our inspection on that car after it is received; possibly the Belt Line will make their inspection of the car when it is received by them twenty miles away, but they do not make an inspection of the car when they deliver it to us. Now, if we object to the condition of that car (and our objections are always based on the fact that we are desirous in the mechanical department of protecting the interests of the Northwestern Railroad) and the car has such defects as to render it unsafe to handle, if it is consigned to the switching district, there is nothing for us to do but to deliver that car back to the Belt Line. There is where the whole difficulty lies. I believe if the Belt Line were to share in the reciprocal feature of the car interchange rules the same as the railroads do with each other, that we can say to the Belt Line, "You received this car from the Lake Shore Railroad in a defective condition, at which time you should have asked for a defect card. Your failure to do so, permits us to call on you to furnish us with card for our own protection before we will accept the car. Failure to do so on the part of the Belt Line, would require them to deliver the car back to the Lake Shore free of charge or repair it at the expense of the Lake Shore Company or the owners of the car as the case may be. In this way, we would receive the same protection from the Belt Road that we do from any other railroad in the interchange of cars."

I believe we have made a mistake and are still making a mistake in our matter of handling cars after they are received by us. The first thing that is done on our cars when a car is delivered to us is to have our seal clerk go over the car and take up the seals to see that they are all right. Following that will be the yard clerk, who

will go along the cars with his record of way bills and card the car for its destination. Following will come our car inspectors and not one of these three makes a note in regard to the inspection of the other. We make a mistake in that we do not consolidate those three functions in regard to the acceptance of those cars and have the inspection of the seals, the yard clerk and the car inspector, all do their work on those cars at the same time. If that were done, a defective car would be disposed of right there and then, without any controversy and without any unnecessary movements in the yard.

Another difficulty that we labor under is in the fact that we receive cars from the Belt Line in Chicago and instead of delivering them back to the Belt Line, as was originally intended if we live up to our agreement, it goes back to them through some other route; we deliver our cars to some of our station connection points and that car will come back to us through the Belt Line. We do not know when the car is received through the Belt Line; nor that the Belt Line received it from the road to which we delivered it. It is difficulties of that character that cause delays, misapprehensions and misunderstandings between the car checkers, car inspectors and the yard masters which cost us annually a great many thousand dollars. I think it has been well stated here tonight that if we had good telephone connections between these points that many of these questions could be settled right then and there and much expense avoided which is now incurred and it would certainly pay in the long run to do it.

PRESIDENT BENTLEY: Mr. Manchester, may we hear from you? You have heard what Mr. Schroyer had to say.

MR. A. E. MANCHESTER (C. M. & St. P. Ry.): I would rather you would call on Mr. La Rue or Mr. Hennessey.

MR. J. J. HENNESSEY (C. M. & St. P. Ry.) I do not know that I am familiar enough with the interchange of cars in Chicago to talk on this subject. I am located some distance from Chicago, but it seems to me from reading over the committee's report, that they are to be complimented on it. If the lines laid down in the report were followed out, I believe that we would not have, possibly one quarter the number of cars being returned that there are under the present system. The great trouble is, as Mr. Schroyer has said, there are too many men handling cars, one department shifting the responsibility onto the other. If cars are to be handled successfully, as the committee suggested, there should be one head and no car should be returned to a railroad unless it be handled through the head of the department designated; it may be the mechanical department or the car accountant's department, but at the same time the various departments must work in harmony. It has been too often the case that when a car is carded for a certain run, the yard clerks right over that same card will put on another billing card sending it somewhere else. This certainly is wrong and should be

stopped. There are many conditions arising that you cannot very well settle in the office. The car must be in such condition that it does not need to be returned. However, it may be refused by some inspector who is a little bit finicky on some purely technical defects. That is wrong. The Car Accountant, yard clerks, yard masters, the switchmen and the car men must work in harmony if these cars are to be handled successfully, otherwise, it is going to be very expensive.

President Bentley: Is Mr. La Rue here?

Mr. H. La Rue (C. R. I. & P. Ry.): I am not inclined to believe the same as Mr. Schroyer that this trouble does not pertain to the whole territory. It has been my practice when we come up against little troubles of this kind to get together and get right next to the fellow that is causing the trouble. I believe that when these troubles come up and they cannot be settled immediately, that if the terminal district will take advantage of the arbitration committee of the General Superintendents' Association and a few examples made that the trouble would soon be ended. We all appreciate the position that Mr. Peck is in and we also believe that a switching road is one of those "buffing posts" in a city that are always necessary, and I do not believe that there is any one better qualified than Mr. Peck, and while he takes a fall out of the rest of us all the time, sometimes it is all right. I was not able to be present at the meeting of the committee, but my representative was there and from what I can gain from the reading of the minutes that this trouble was local rather than otherwise. It is also my opinion that if each railroad will assume its responsibility under the rules of the General Superintendents' Association of Chicago, we will not have these local troubles, and that I believe was the reason the committee had for drawing up these few rules which, to my mind, govern the whole case.

Mr. Peck: Mr. Schroyer's point has not been answered yet, referring to the Belt Line. I want to see the rules enforced. I believe as Mr. La Rue says, that there ought to be a case brought before the Arbitration Committee. But here is a rule of the General Superintendents' Association that is larger than Lake Michigan. Take Rule 3: "Loaded cars offered in interchange must be accepted with the following exceptions: Cars that cannot be safely handled." There is the whole thing in a nutshell. It is all in the judgment of the inspector. I give you some cases. We have offered cars to the St. Paul and Northwestern roads when that were going only half a mile or a mile on their track, but the inspector says, "I won't take it." The car was safe to run; I have taken the car back twenty-five miles over our track and delivered it back safely. Why wasn't it accepted? That is where the judgment of the different inspectors comes in, that it is safe and not safe. We do not very often have a car that breaks down, after it is refused, on account of not being

safe to run. We have had cases in the elevator district of a car refused because unsafe which would have had to go but half a mile to reach its destination; we hauled it back probably twenty miles and the car arrived safely, which goes to show that we would have less trouble if we did not have so much inspection. Not long ago the Lake Shore refused a car which had to be moved but a mile on their line and when I took it up with the Master Car Builder, he said, "Let the car go." He took it and it came back safely. We inspect for the Belt only; if the car is safe to run, we take it to run over the Belt. When it comes to the Northwestern, the St. Paul or other connections, that inspector says it is not safe to go a mile on the track and we haul it twenty miles back in safety. That shows that the man who refused it had poor judgment.

Mr. Schroyer: I would like to say a word in answer to that. Mr. Peck says he hauls a car twenty miles that nobody else would haul half a mile. Now, Mr. Peck will take any car for twenty miles for a consideration; that is what he is doing it for, and he always wants consideration when we refuse to accept a car on account of damaged condition and he wants consideration for hauling it back. Now we all know the bulk of damage is done in switching cars and we know when a car is sent to one of our interchange points, that that the car must be handled through the switching district and repeatedly through the switching yards and that is the time that there is the greatest liability of damage. I think that that answers the question pretty well. This paragraph, Clause A of Rule 3, "Cars that cannot be safely handled," is the whole thing in a nutshell, and I say that when the Belt Line Railroad receives a car at one of these connections that we cannot handle safely through our switching yards and they deliver it to one of our connections, they should take it back to the point where they got it, free of charge, and not put us to the expense of doing it. That is the whole trouble. The Belt Line requires protection from the road they receive the car from, so we have protection when the car reaches us. Now that refers to cars that can be safely handled. Our rules and the rules of the Car Foremen's Association require that all cars that can be safely handled to points outside of the switching district should be accepted and if repairs can be made by the receiving road they should be made. Loaded cars consigned to points outside the switching district received in bad order, if they cannot be safely handled, must be set on the transfer track and load transferred at the expense of receiving road and empty car returned to the delivering line. Could anything else be fairer than that? Different conditions prevail when it comes to cars consigned to the switching district. We are not required under the rules of the switching district to accept the cars consigned to any of these points that cannot be safely handled and very much of our trouble is right in there.

President Bentley: Is there any member of the General Su-

perintendents' Association here who could give us a little light on this subject, any operating department officer?

MR. RICHMOND: Before going further, I would like to ask a question. Supposing a foreign line would deliver a car without any brake, the brake attachments were disconnected, the brake beams were gone; we receive the car from a foreign line, our yard is over here on the hill, we accept the car and under the car rules the car is delivered for unloading. Finally we get the car unloaded, and after a certain time some of our yard foremen in making the delivery gets the car to the wrong connection, or we receive the car from the C. M. & St. P., and one of our car foremen says that our yard foreman delivered the car to the Northwestern. That is a delay to empty cars at terminals. What I would like to get is information how you are to overcome delays to cars at terminals, on whom to place the blame and how it is to be corrected? If it is not right to charge that up to the yard master, the yard clerks that had the mishandling of that car, let it be charged to the foreman in charge of one of the switching districts. That is one question that I would like to hear debated; how we can overcome that matter in handling foreign cars.

MR. PECK: What the gentleman is talking about is just what we are trying to avoid, taking the car home on the old route on account of bad order. That car should have gone back to the St. Paul.

PRESIDENT BENTLEY: I understand Mr. Beecham is here, the author of this paper, we would like to hear from him if he is in the room.

MR. W. E. BEECHAM (C. M. & St. P. Ry.): It has been remarked at the opening of this discussion that the trouble complained of is not epidemic. That may be considered a very fortunate thing for the railways, because if it were it would go a long way towards depleting their treasuries.

I have on my desk at the present time a list of thirteen foreign cars which have made many unnecessary, useless and wasteful movements between our line and other lines, mostly via the Chicago Belt. The per diem and trackage accruing on those cars while in nobody's service amounts very closely to $300.00, which is just exactly like taking so much money and throwing it away. And I want to say, and I wish to emphasize it, that no attempt has been made to collect evidence for this occasion, and therefore I am not able to say what such movements would amount to in money in the aggregate, in the course of a year, but it would undoubtedly be a very large sum. *It is a wasteful practice* and, in my opinion, the car departments of the railroads centering in Chicago are very largely to blame for it.

Mr. Peck has suggested that we inspect for safety only. I believe in that idea. It seems to me that the magnitude of the operations in a terminal like Chicago requires that everything should be done that can be done to expedite the movement of cars. I don't know

whether you all understand it or not, but the General Superintendent's rules governing the interchange of cars in Chicago require all cars belonging to roads centering here to be returned to the owners direct. Foreign cars which don't belong to railroads centering here must be returned to the roads they were received from or loaded for home. It is with the foreign cars that we have the most trouble. There is something wrong, in my judgment, with your methods of taking and keeping a record of the defects existing in cars, also with your conclusions in regard to the condition of cars.

You may think it unkind of me to say it, but I am led to believe, from some of the investigations that I have made, that it is well nigh impossible for car men, Master Car Builders or Superintendents of Motive Power to agree upon the condition of a car or who is responsible for the same in case of dispute. I hold in my hand some correspondence between Mr. Coller, Monon; Mr. Peck, Belt; Mr. Morris, St. Paul; and the conclusions that I draw therefrom are that neither one of those gentlemen know what the condition of the car in dispute was. (Laughter).

Now I would like to ask you to tell me how I am going to know anything about it. I am not a car builder and not qualified to judge and all that I know about it is that cars are thrown in the air, and while this is being done, money, labor and time is being wasted. Let me give you an instance. A few days ago an old wreck, a Soo Line car, came to our yard from one of our connections under a home route card. Our people rejected it because it was unsafe to handle, and they had a right to do so. The case was referred to my office and when I asked about the condition of the car I was told that it was worn out. I then ordered it returned to the delivering line, but our people said, "We cannot return it. It won't stand the journey." I said, "You must, as we won't have it," and in trying to return the car it was pulled to pieces. We gathered up the pieces, took them to our yard, patched them together and got the old hulk under way again, and a second time it was pulled to pieces and the pieces were returned to our yard. I don't know what the final outcome in this case is going to be. I think we ought to make scrap of the car, but I don't believe we can consistently do so. The delivering line said, "You have got to take it, because it has a home route card," but we disabused its mind of that impression, and in time we hope to get the old hulk started again and I trust we will succeed in getting rid of it.

Now, gentlemen, in all seriousness, let me say that I have no hesitation in denouncing the practice to which I allude as extremely unreasonable and I want to promise you that if you will put a stop to the unnecessary movements of cars, occasioned by disagreements over responsibility for their physical condition, I will take it upon myself to guarantee that the Transportation Departments will join

hands with you in putting a stop to all such movements. It is undoubtedly a fact that improper movements are occasioned by the Transportation Departments in this way: A car is received from a connecting line under load and when made empty is returned to the delivering line without carefully looking up its record, because the man handling the case does not go back far enough to know whether it routes home via the receiving line or not, but such movements as that don't amount to very much. It is just as easy to settle all questions, such as responsibility for the physical condition of a car, proper home route, etc., while the car is standing still as it is while it is in motion, and it is a great deal cheaper.

MR. PECK: They all refer to the Belt Line and the twenty miles made by the car in this case. Now, the cars Mr. Beecham describes in this case might be dismantled, but his own car men accept cars and the car he mentioned his car men are not responsible at all, because it was returned by the agent or clerk. He refers to the correspondence and says we do not know anything about the condition of the car, but we know just as much about the condition of that car as Mr. Beecham does about the moves some of the cars make on his road. I know some of the cars Mr. Beecham has brought in over the B. & O. and Lake Shore, and I know that our car man had nothing to do with them. If he calls the car man's attention to it, the car man leaves it marked in bad order, then the car man will take care of it, but if our agent finds nothing of that kind, they accept it for switching, they make a record of it and have a copy sent to Mr. St. Paul, but the car Mr. Beecham speaks of is known to all car men.

Regarding the bills, there are entirely too many made out. It takes a large force in every railroad office in the city making out unecessary bills. I was informed a few days ago by a prominent car man that his company received each month bills for from $15,000 to $20,000 and that it billed for about the same amount. If the practice I advocate was adopted it would do away with all this unnecessary billing and extra office help. I do not think we realize the vast increase in business in Chicago in the last few years. It has increased from 200 to 400 per cent; there has also been a large increase in the number and capacity of both locomotives and cars, but the rules of interchange has not kept pace with the increase of business, because we are handling cars in the same manner as in 1896. Mr. Harriman of the Illinois Central informed the Inter-State Commerce Commission of the increase in business on his road in the last 12 years and it was published in the Railway Age a short time ago. The freight handled increased 263 per cent; the number of freight cars increased 291 per cent; hauling capacity of locomotives increased 346 per cent; tonnage capacity of cars increased 665 per cent; number of locomotives increased 144 per cent; number of freight cars loaded increased 128 per cent. While this is the

record on the Illinois Central no doubt other large systems increased as much and possibly some of them more. Wages of all classes of employes have increased in the last year and there will be a large increase in per diem in July, this year. I think it behooves the car men of this city to decrease the cost of handling and inspecting cars to compare with the increase above mentioned from 141 to 600 per cent.

My idea that the "20th Century Inspection" heretofore explained would do this. In conversation with a prominent Pennsylvania official a short time ago I was informed that the company has adopted this system in Cincinnati. I think it was introduced by Mr. H. Boutet, president of the Chief Joint Car Inspectors' Union of the United States. If this system works in Cincinnati I see no reason why it would not work here as the interchange is heavier and there is more need of it than in Cincinnati. The rules of interchange adopted in 1896 were first prepared and adopted by the members of this Club. I see no reason why the Master Car Builders, members of this Club could not get together and formulate a new set of rules, because our methods of car interchange and inspection are away behind the times. We are not keeping pace with the heavy business. There has been a car shortage in the last year that is unheard of and by revising the rules so that cars would not be detained so long for inspection a great deal of this could be avoided, as I have previously shown.

PRESIDENT BENTLEY: We have had a good deal of amusement out of this paper; it is a very serious matter, however, very serious indeed, and from the discussion that has taken place it does not appear to me that we need any more rules, but to have the absolute enforcement of the rules that we have in effect. Now, the question is, how are we going to get at it? It is, gentlemen, a very serious matter when we think that cars are being moved back and forth here doing nothing, getting nowhere, and particularly so when we are hard up for equipment.

MR. PECK: I move that the report of this committee be adopted. We might try it for a little while.

C. A. SELEY (C. R. I. & P. Ry.): I would like to amend that motion by saying further the copies of this report and also the discussion of this evening be transmitted to the General Superintendents' Association and to each member of the Arbitration Committee, mentioned in the report.

PRESIDENT BENTLEY: Do you accept that amendment?

Amendment accepted.

MR. SCHROYER: That does not include what Mr. Beecham said just now, does it?

MR. LA RUE: I would like to have a copy of the minutes referred to the Car Foremen's Association of Chicago.

Amendment accepted.

MR. JOHNSON: The car department, in my mind, can do something further to relieve the operating department of unnecessary delays. We have been called on from time to time to return to connecting lines cars containing perishable freight and high class freight of all kinds—live stock on one or two occasions—and thereby cause a delay of thirty-six to forty-eight hours to the car, on account of such defects as a lag screw being missing, a grab iron loose, a draw bar a quarter of an inch too low or too high, a running board broken or possibly a brake chain or screw missing. Now that, I think, is contrary to law. In all those cases, the law says that the delivering line shall deliver the cars in good order; they go over to the connecting line, connecting line inspector finds one of these defects, which perhaps our inspector overlooked, and the result is that the yardmaster of the connecting line says to the delivering line, "Send an engine over and get the car; we won't handle it." We are therefore obliged to send an engine over for the car, and I believe, in moving the car we are violating the law when we permit the car to go back to our line in bad order with defective safety appliances. It seems to me if these car men would get together they might find a better way out of this predicament; it might pay to have a joint man at the different points of interchange to make such light repairs and avoid the return to delivering line of cars that they have delivered in bad order, which condition usually occurs enroute.

MR. W. E. SHARP (Armour Car Lines): It appears to me from the discussion that possibly the General Superintendents will have difficulty in deciding whether it is the mechanical department or the transportation department that is responsible for these erroneous moves. May I suggest that Mr. Beecham and Mr. Schroyer volunteer to explain to them. I understand there is a neighboring city where they do not have these troubles at all, and before this discussion is closed I would like to hear from a gentleman who has recently come from St. Louis; I refer to Mr. George Hannauer, at present time Superintendent of Terminals of the C. I. & S. Ry.

PRESIDENT BENTLEY: Mr. Hannauer, we had you in mind; we would like to have you give us a few words about the lack of difficulties you have in St. Louis.

MR. G. HANNAUER (C. I. & S. Ry.): I hardly feel like offering advice to Chicago, because I have have only been here about six weeks and I must not be understood as trying to offer advice. Mr. Sharp, in talking to me about this, suggested that these matters seemed to be largely overcome at St. Louis, and I do not mind telling you briefly how it is done, if you care to hear it.

They have used there in the last two or three years a joint inspecting system which carries out to the limit this recommendation 4 in the committee's report. The rules are all good, they are thoroughly backed up as a whole and the Chicago rules are good. I think St. Louis in framing its rules, tried to out-Chicago Chicago. that is, fol-

lowed the Chicago practice and went just a little farther. For example, in Rule 3 they cut out that clause "A" about cars that cannot be safely handled and they tell the receiving line, whether a switching line or a trunk line, that if the cars are not safe to handle, to make them safe and it worked no serious hardship on anyone. An exception is made, of course, in the matter of defective safety appliances.

I heard somebody speak about hauling cars twenty miles and then twenty miles back because the cars are unsafe for the receiving line to place them for unloading in the switching limits. By cutting out the clause "A" you would not double haul very many cars and the work of the switching line would be more satisfactory to the public, which does not relish the delays that result from setting back cars. At St. Louis the interchange is about 15,000 or 16,000 cars per day of which the strictly switching lines handle between 9,000 and 10,000 cars. All of this latter number are handled on a switching basis for delivery from a trunk line to an industry or team track, or from one trunk line to another. The business between the trunk lines is more than 50% of the total, and every car is handled on the basis of setting back no loads except those that are in violation of Safety Appliance laws.

They have also cut out clause "C." The Freight Claim Agents were called in and they assisted in framing a rule under which the receiving line handles a leaky car for the account of the delivering line. Of course, the delivering line is communicated with by 'phone or wire as to its wishes. The receiving line handles the car on the theory that as a rule the leakage is discovered by the inspectors of the receiving line at a considerable distance from the yards of the delivering line. To haul it back would mean more loss and take more time than stopping the leakage. The receiving line undertakes to protect the freight the same as it would if it belonged to it. The expense, of course is charged to the delivering line.

Now, as I started to say in the beginning, the rules are good, the Chicago rules are fine, and all these problems can be solved if we will go a little further along the lines of the Chicago policy and then put it in the hands of someone who will see that the rules are carried out. When St. Louis rules were carried out by thirty or forty different car foremen, each placing his own interpretation upon the rules, they had a great many differences of opinion and a great many seesaw movements. They still have some, because the rules are not yet perfect and I do not suppose they ever will be so long as certain government inspectors take such an arbitrary stand on the matter of defective safety appliances, but St. Louis found it impossible to have its rules carried out until it created a bureau to carry them out and gave the chief of that bureau absolute jurisdiction over all car inspectors in the district in the matter of carrying out the in-

terchange rules. They also gave him the power to issue instructions pertaining to the rules of interchange and the power to order the removal of any interchange inspector who did not carry them out.

PRESIDENT BENTLEY: Mr. Peck has made a motion that the report of the committee be accepted and a copy of these reports be sent to the General Superintendents' Association and also copies to the Car Foremen's Association. Is there any one to second that motion?

Seconded by Mr. Seley and carried.

PRESIDENT BENTLEY: Gentlemen, before the Secretary reads the annual report of the officers, I think somebody ought to make a motion to give Mr. Beecham a vote of thanks for the very excellent paper that he brought out here and also a vote of thanks to the committee who looked this thing over and also reported on it, for both the paper and the report of the committee have brought out a very nice discussion to-night, which has been of very great value to us. Does anybody want to make that motion?

MR. SELEY: I make a motion as stated by the President.

Seconded.

MR. MANCHESTER: The motion has been seconded. I wish to say this, that discussions of this kind can be made useful and beneficial to the railroads and I believe to all who are interested in the movement of traffic, and I want to say again what I said the other night after Mr. Beecham had read his paper and that is that one of the serious troubles in connection with getting together on all these propositions is that one gang gets together and they pat each other on the back and say they are not the fellows that did this, it is the other crowd. And if we can get all these crowds together and let them all tell their troubles right out in meeting, that will bring good results, and I believe, without there is some better Association in the city, that the Car Accountants and more of the Superintendents would do well if they would get together in meetings of this kind and discuss these very live and annoying topics that are constantly before the railway men in moving traffic through large terminals like Chicago.

MR. BEECHAM: Before that motion is put, I would like to say that it is not thanks that I want, it is performance that I want.

PRESIDENT BENTLEY: Well, it is moved and seconded that a vote of thanks be given Mr. Beecham and the committee on this subject and in connection with that we hope that the reforms much needed will be forthcoming, Mr. Beecham. All in favor, signify by saying aye.

Motion carried.

PRESIDENT BENTLEY: Mr. Beecham, we wish to thank you very much for the interesting paper and discussion.

The next "menu"—that sounds good—as though we would have something to eat, but we are not—is the report of the Secretary and Treasurer.

To the President and Board of Directors of the Western Railway Club:

With this meeting the twenty-third year of the existence of the Western Railway Club closes, and as has been the custom heretofore, a brief resume of the transactions of the Club is given below:

Membership.

The membership shows a good, healthy growth, the present number being the largest its history.

Membership, April, 1906		1,271
Resigned	44	
Deaths	11	
Dropped for various reasons	41	96
		1,175
New members admitted during the year ending April, 1907	210	
Reinstated	2	212
Total membership		1,387

The following is a list of those taken from the membership list for various reasons:

Mail Returned.

Brown, F. D. B.
Elling, W. F.
Hunder, W. L.
Johnson, G. C.
Palm, E.
Rider, W. A.
Roe, C. E.
Stone, A. H.
Thomas, A. H.
Wilson, W. M.

Non-Payment of Dues.

Beebe, G. W.
Benson, A. E.
Blennerhassett, W. S.
Boone, C. T.
Bowles, C. K.
Brady, J. J.
Brown, Jos. M.
Brown, T. R.
Bryant, W. E.
Campbell, E. J.
Colville, R. W.
Courtney, D. C.
Dersh, F. H.
DeWolf, J. O.
Galivan, J. B.
Herbert, F. W.
Johnson, F. D.
Kellogg, D. P.
Latimer, J. B.
Langston, J. E.
Leonard, J. W.
Maguire, J. D.
McLeod, A. E.
McLeod, J. B.
Moriarty, John
Morse, F. H.
O'Leary, Jas.
Peach, J. P.
Rogers, C. W.
Stern, K. J.
Stolpe, G. E.

Resigned.

Antz, Oscar
Bern, E. A.
Borton, C. C.
Breeze, A. B.
Buenting, O. W.
Chambers, W. C.
Coats, R. N.
Coggshall, J. E.
Colling, W. G.
Correll, E. I.
Cross, C. W.
Davis, M. J.
Ellis, G. E.
Emmert, T. H.
Emmett, R. S.
Essley, E. L.
Gavney, E. T.
Grossman, A. B.
Hall', J. E.
Hawksworth, D
Higby, Theron
McIntyre, A. F.
Kerr, E. W.
Markle, J. H.
Maxwell, R.
Medway, J.
McKean, M.
McLean, G. A
Meissner, O. W.
Merrill, J. J.
Nelson, G. L.
Nuckols, C. C.
Patterson, J. B.
Price, D. M.
Purdy, G. C.
Rees, E.
Royse, Dan'l
Shaad, H. J.
Slaughter, G. F.
Taylor, C. M.
Taylor, E. S.
Van Dresar, E. L.
Wellman, I.
Worthington, B. A.

DEAD.

Atkinson, G. W. P.	Henry, C. S.	Saltar, John, Jr.
Clodgis, Frank	Kuhlman, H. V.	Schevers, A. J.
Dickinson, Paul	McGuire, W. A.	Sprague, W. T.
Dunn, M.	Nicholson, G. B.	

As will be noted death has claimed an unusually large number of our members. In accordance with our usual custom a page will be set apart in the record of our proceedings on which an entry may be made of those who have died during the year.

FINANCIAL.

From the Treasurer's books the following details of receipts and expenses are taken:

RECEIPTS.

Balance on hand May 15th, 1906	$1,452.21	
Receipts from all sources	5,914.35	
Total receipts		$7,366.56

EXPENSES.

Binding annual proceedings		$ 393.93	
Cost of advertisements		611.60	
Library:			
Salary Librarian	$240.00		
Insurance	7.80		
Rent library room	380.50		
Library furniture	329.25		
Incidentals	41.30		
		998.85	
Office expenses		151.22	
Postage		377.53	
Printing		2,391.88	
Reporting proceedings		259.63	
Salary secretary		300.00	
Express		145.22	
Telegrams		1.59	
Total expenses			5,631.45
Balance on hand			1,735.11

The only indebtedness the club has is shown by the bills approved by the Board of Directors today, amounting to $457.86.

The bills receivable are as follows:

From advertising	$1,139.25
From annual dues—$4.00	266.00
From annual dues, $2.00	288.00
From sale of proceedings	40.50
Total	$2,733.75

The assets of the club in so far as available funds are concerned can be estimated about as follows:

From advertising	$1,139.25
From sale of proceedings	40.50
From payment of dues, 25 per cent off	414.00
Unappropriated balance	1,277.25
Total available assets	$2,871.00

As was referred to in the last annual statement of your Secretary, the Club Library has been refitted and furnished, new book cases, library furniture has been obtained and the books are now so arranged that they are available at all hours of the day.

The matter of index has not yet been completed, but it is hoped the coming summer will see the work of compilation finished.

The report of your Treasurer shows the club to be in good shape. The funds on hand are increasing at a not too rapid rate, but in about the same relation as the increase in membership, which indicates a healthy condition.

Respectfully submitted,

JOS. W. TAYLOR, *Secretary*

CHICAGO, May 3, 1907.

To Officers and Members of the Western Ry. Club:

I take pleasure in handing you my Ninth annual report as Treasurer.

Receipts		Paid Out	
Cash on hand, May '06	$1,452.21	May	$ 566.76
Rec'd from Sec'y 7-18	732.50	July	523.77
Rec'd from Sec'y 8- 9	910.00	Sept.	1,087.66
Rec'd from Sec'y 9-18	398.75	Oct.	430.08
Rec'd from Sec'y 10-15	288.50	Nov.	548.01
Rec'd from Sec'y 11-19	759.45	Dec.	454.23
Rec'd from Sec'y 12-17	572.00	Jan. '07	397.81
Rec'd from Sec'y 1-14	193.50	Feb. '07	602.02
Rec'd from Sec'y 2-19	610.00	Mar. '07	344.71
Rec'd from Sec'y 3-19	550.25	Apr. '07	676.40
Rec'd from Sec'y 4-16	404.25		
Rec'd from Sec'y 5-21	495.15		
Total	$7,366.56		
Paid out	5,631.45		$5,631.45
Cash on hand, May, '*7			$1,735.11

P. H. PECK, *Treasurer.*

PRESIDENT BENTLEY: You have heard the report of the Secretary and Treasurer; what is your pleasure, gentlemen? They should be referred to the auditing committee.

Motion to refer to the auditing committee was carried.

THE SECRETARY: I have also the report of the trustees of the library.

To the Officers and Members Western Railway Club:

The Trustees of the Western Railway Club library beg to report a substantial advance in the status of the library for the past year. It is now installed in desirable quarters, Room 375, Old Colony Building, Chicago, adjacent to the offices of the Secretary and of the Librarian.

The books have been placed in neat cases and the room has been provided with comfortable chairs, tables, rugs, curtains and pictures. The room is a very desirable one for Committee meetings.

On account of these conveniences and the amount of information, scope and range of the literature on its shelves, the library offers to the members of the Club an exceptional opportunity when information is desired. A very cordial invitation is extended to all members to visit the library, to ascertain for themselves just what we have and to avail themselves at any time of its privileges and the Librarian will be glad to assist searchers for information.

It is expected, within the next few months, to have a complete catalogue and index made covering present contents of the library.

A detailed report from the Librarian is attached showing the additions to the library received during the last year, and we would suggest to members that contributions of suitable literature are always acceptable.

We desire to commend the personal efforts of the Librarian and of the Secretary who have untiringly assisted in bringing about the present satisfactory arrangement and equipment of the library.

Respectfully submitted,

C. A. SELEY, *Chairman*,
W. F. W. GOSS,
F. W. SARGENT.

Chicago, Ill., May 18th, 1907.

ACCESSIONS TO WESTERN RAILWAY CLUB LIBRARY SINCE JUNE, 1st, 1906.

Baldwin Locomotive Works: Record of Recent Construction No. 56.
Baldwin Locomotive Works; Record of Recent Construction No. 57.
Secretary: Transactions American Society of Mechanical Engineers, Vol. XXVI, 1905.
Baldwin Locomotive Works: Record of Recent Construction No. 58.
B. F. Sturtevant Co.: A Treatise on "Ventilation and Heating."
B. F. Sturtevant Co.: Series of Engineering Files.
Railroad Gazette: Thirty-fifth Annual Report of the Railroad and Warehouse Commission of the State of Illinois.
Isaac B. Brown, Secretary: Pennsylvania Annual Report of the Secretary of Internal Affairs—Part IV.
R. C. Richards: "Railroad Accidents, Their Cause and Prevention."
Railroad Gazette: Special Report of the Railroad and Warehouse Commission of the State of Illinois.
Railroad Gazette: "Universal Directory of Railway Officials"—1906.
Frederick J. Drake & Co.: "Modern Locomotive Engineering."
University of Chicago Press: "Railway Organization and Working."
Roebling Construction Co.: "San Francisco Earthquake and Fire."
Railroad Gazette: "Locomotive Dictionary."
Railroad Gazette: "Car Builders' Dictionary" (1906 Edition.)
Railroad Gazette: "Rights of Trains on Single Track."
Railroad Gazette: "Roadmasters' Assistant."
Railroad Gazette: "Cost of Locomotive Operation."
Railroad Gazette: "American Railway Shop Systems."
Railroad Gazette: "Yards and Terminals and Their Operation."
J. W. Taylor, Secy. M. M. & M. C. B. Assns., 30 Vols. of Inst. of Mechanical Engrs. of Great Britian.
J. W. Taylor: Report of Proceedings Amer. Ry. M. M. Assn., 1906.
J. W. Taylor: Report of Proceedings Master Car Bldrs. Assn., 1906.
A. Bement: "Peabody Atlas of Coal Mines and Railroads."
The following is a list of the volumes bound for 1906:
The Engineer (London).
Engineering (London).
Engineering News.
Railroad Gazette.
Engineering Record.
Railway & Engineering Review.
Electrical World.
Street Railway Journal.
Railway Engineer (London).
American Engineer & Railroad Journal.
Street Railway Review.

American Machinist.
Locomotive Engineering.
Railway Master Mechanic.
Electric Railway Review.
Railway Age.
St. Louis Railway Club.
Journal Association of Engineering Societies.
Engineering Magazine.
Journal Western Society of Engineers.
Sibley Journal.
Engineering & Mining Journal.
The Engineer (Chicago).
Fifty-four volumes presented; 31 volumes bound; total 85 volumes.

PRESIDENT BENTLEY: That report will be received and placed on file. Next subject on the program is the election of officers. Before starting, I wish to ask Mr. J. J. Hennessey and Mr. William Forsyth to act as counting tellers and Mr. E. W. Pratt and Mr. C. H. Fry, Jr., to act as collecting tellers.

The Secretary read from the constitution the provision in regard to elections. It will be in order now for the members to prepare an informal ballot for the President.

MR. PECK: I make a motion that the Secretary cast the ballot of this Club for Mr. Seley as President.

PRESIDENT BENTLEY: Mr. Peck, according to the by-laws that is not legal.

MR. MANCHESTER: Not until after the informal ballot.

PRESIDENT BENTLEY: The collecting tellers will now proceed to collect the ballots for President. If all the members have voted, I hereby declare the ballot closed.

The informal ballot for President resulted as follows: Mr. C. A. Seley, 60; Mr. H. T. Bentley, 7; Mr. E. A. Manchester, 1; Mr. M. K. Barnum, 1; Mr. C. A. Schroyer, 1; Mr. P. H. Peck, 1.

On motion of Mr. Manchester, duly seconded, the Secretary was instructed to cast the unanimous ballot of the Club for Mr. Seley. The ballot was so cast and Mr. Seley was declared elected President for the ensuing year.

Informal ballot for First Vice-President was then taken, which resulted as follows: Mr. M. K. Barnum, 54; Mr. H. T. Bentley, 1; Mr. P. H. Peck, 1; Mr. J. F. DeVoy, 1; Mr. W. E. Sharp, 1.

On motion of Mr. Manchester, duly seconded, the Secretary cast the formal ballot of the Club for Mr. Barnum, whereupon he was declared elected First Vice-President.

The informal ballot for Second Vice-President resulted as follows: Mr. W. E. Sharp, 42; Mr. C. A. Schroyer, 5; Mr. W. E. Symons, 2; Mr. Knapp, 1; Mr. A. E. Manchester, 3; Mr. Clark, 1; Mr. C. B. Young, 2; Mr. E. W. Pratt, 5; Mr J. F. DeVoy, 1.

On motion, the Secretary was instructed to cast the ballot of the Club for Mr. W. E. Sharp, whereupon he was declared elected Second Vice-President.

An informal ballot for Treasurer resulted in 75 votes being cast for Mr. Peck, 3 for Mr. Schroyer and 1 for Mr. Sharp.

On motion of Mr. Seley, the Secretary cast the ballot for Mr. Peck, whereupon he was declared elected as Treasurer.

MR. BRYANT: I offer the following resolution on behalf of the Western Railway Club: That a vote of thanks be offered to our Treasurer, Mr. Peck, who has served for the past fifteen years continuously without compensation, and the Board of Directors are hereby instructed to expend such an amount for a token of appreciation of his services, as they may deem sufficient.

PRESIDENT BENTLEY: The motion is that in appreciation of the services of Mr. Peck, without remuneration, the Board of Directors be empowered to secure a suitable token for Mr. Peck.

Motion carried unanimously.

PRESIDENT BENTLEY: In order to save time, it has been suggested that the Secretary cast the ballot for the trustees of the library. This can be done lawfully and without disregarding the By-laws of the Club.

MR. SELEY: Mr. Chairman, I object. Having served as chairman of the trustees of the library for two or three years, and having been honored this evening by being elected as President, I do not think Mr. Seley is a very fit subject for chairman of the Board of Trustees under the circumstances. I do not believe in a man holding two jobs and drawing two salaries, and I think in an Association having 1,400 members, it is not necessary for any man to hold two jobs, I therefore hope that nominations will be made for a third member, retaining the other two members which are already on the Board.

MR. BRYANT: I quite agree with Mr. Seley. I make a motion that we withdraw his salary.

It was moved by Mr. Peck that the Secretary cast the ballot for the Board of Trustees, which motion was carried and the following members were declared duly elected: Messrs. C. A. Seley, F. W. Sargent and W. F. M. Goss.

It was moved by Mr Pratt and duly seconded that the three members receiving the highest number of votes be declared elected as directors for the ensuing year. Motion carried.

PRESIDENT BENTLEY: The Secretary will now read the names of the candidates and the numbers of votes received.

THE SECRETARY: The vote is not unanimous for any three directors. Mr. Young has received 49 votes; Mr. Bryant, 41; Mr. Bentley, 10; Mr. Stimson, 7; Mr. DeVoy, 25; Mr. Taylor, 2; Mr. Carney, 2; Mr. Manchester, 7; Mr. Symons, 8; Mr. La Rue, 10; Mr. Beecham, 3; Mr. Peck, 2; Mr. Pratt, 3; Mr. Hennessey, 1, etc. The three highest are Messrs. Young, Bryant and De Voy.

Mr. C. B. Young, Mr. G. H. Bryant and Mr. J F. De Voy were declared duly elected as members of the Board of Directors.

President Bentley: I wish to appoint Mr. Manchester a committee of one to escort the new President to the chair.

Mr. Manchester: Gentlemen of the Club, I take pleasure in presenting to you the President for the ensuing year. He has a very elaborate speech prepared and we will now listen to it. (Applause.)

Mr. Seley: I have some impromptu remarks very carefully prepared. I wish to say only that so far as filling the chair is concerned, I will do the best I can. It is up to you gentlemen to make success of the Western Railway Club for the ensuing year. You have heard the report of the Secretary that we have 1,400 members, I hope that when my successor is escorted to the chair that the record will be 1,600, and I look to the members on the floor to assist the officers of the Club in bringing about that number. We also want good papers, we want good attendance, and I see no reason why, with the growth which we had this past year in numbers, in finance and all other ways, but that it should attain the desired end. I beg to thank you very much for the honor which you have given me this evening and desire that you will excuse errors, if any, of the administration this year. (Applause.)

Following the installation of officers the following entertainment was thoroughly enjoyed by the members:

Music .... Weber Quartette

(A plaintive air preparatory to the introduction of the first speaker.)

Address by Mr. Jack Lanier, Representative of the Southern Smelt. & Steal Company, entitled: *"The President's Railroad Policy: Is It Right?"*

Music .... Weber Quartette

(An inspiring song. Sam Davis at his best.)

Address by Mr. Robert Wassmann, President Trans-Atlantic & Pacific Lock & Varnish Co., subject: *"How to Extract Orders From and Manipulate a Purchasing Agent."*

Mr. Wassmann but recently joined the ranks of the Brotherhood of Railroad Supply Men, and promulgated some original and instructive ideas as to manipulation, etc.

Music .... Weber Quartette

In Memoriam

G. W. P. Atkinson
Frank Clodgis
Paul Dickinson
M. Dunn
C. S. Henry
H. V. Kuhlman
W. A. McGuire
G. B. Nicholson
John Saltar, Jr.
A. J. Schebers
W. T. Sprague

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OFFICIAL PROCEEDINGS

Western Railway Club

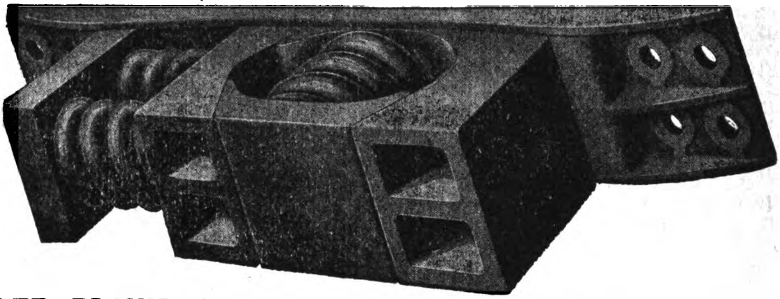
VOL. 19 May 21, 1907 No. 9

Paper for Discussion:

REPORT OF COMMITTEE ON DELAY IN MOVEMENT OF EMPTY CARS AT TERMINALS

ELECTION OF OFFICERS

THE BUTLER FRICTION DRAWBAR ATTACHMENT



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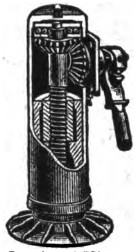
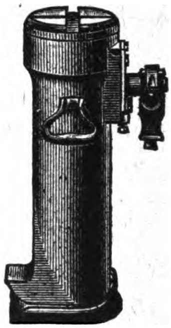


Sectional View Norton Jack



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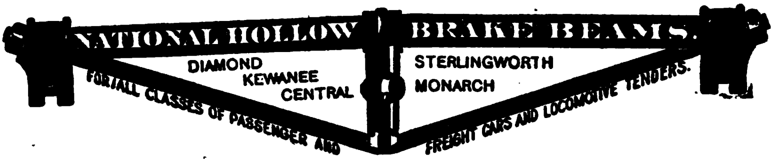

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St. Louis Bank of Commerce Bldg. — F. A. Goodrich; W. M. Armstrong; H. W. Fennel

New York — F. G. Ely, 24 Broad St.; E. G. Buchanan, 26 Cortlandt St.

Washington—B. F. Pilson, 17 Sun Bldg.

Montreal—I. A. Young, 22 St. Johns St.

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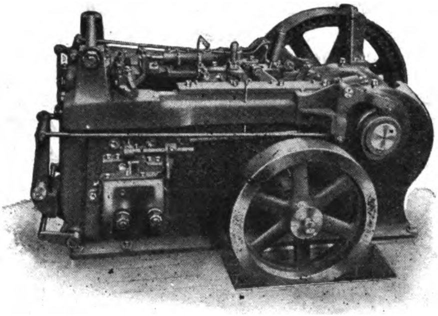

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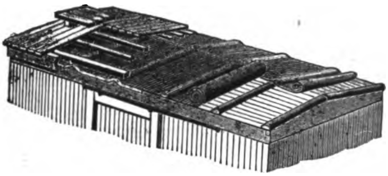

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Classified Index of Advertisements

Index—Continued

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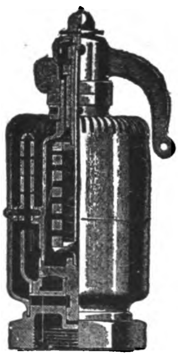

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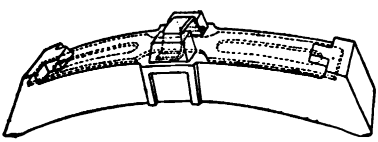

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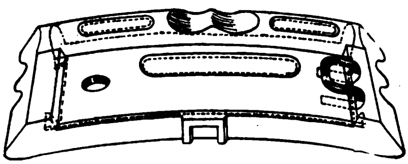

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